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THE ROENTGEN DIAGNOSIS OF INTESTINAL OBSTRUCTION[1]

by

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It may be very difficult to make the clinical diagnosis of intestinal obstruction in the first twenty-four hours, because of the fact that the symptoms typical of this lesion may be totally or partly absent. When regarding the classical symptoms of intestinal obstruction it will be noticed that the relation of the pain generally gives rather indefinite data on which to base the diagnosis, as it is essentially indistinguishable from colicky pain with other causal relation. Further, the pains has no typical location. Neither do the vomitings supply informative facts before the vomitus is becoming foul. This is a late symptom, however, and indicates that the situation is on the point of becoming exceedingly grave. Information to the effect that there has been no passage of feces or flatus is of small value during the first twenty-four hours. Besides, one may often observe that patients suffering from intestinal obstruction have spontaneous defecation with discharge of flatus some time after the onset of pain. The feeling of oppression, which is frequently pronounced, may perhaps be of more value.

The objective findings are also scarce during the first twenty-four hours. Meteorism may be slightly pronounced, or it may be entirely absent. Visible peristalsis and the so-called Wahl balloon symptom (»hypogastric football») are important findings. They are only rarely demonstrable, however. Borborygmus and squirting sounds associated with the attacks of pain are effective data on which to base the diagnosis. They may also be present, however, when there is no obstruction. Increase in the quantity of peritoneal fluid occurs early in intestinal obstruction. CHRISTENSEN has demonstrated this in operations as early as

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3½ hours after the onset of the attack. In spite of this, however, dulness due to exudate is fairly rarely demonstrable during the first twenty-four hours.

Increased non-protein nitrogen in serum, which is a very valuable symptom in the further course of an intestinal obstruction, is absent as a rule during the first twenty-four hours (PLATOU).

It was of invaluable importance, therefore, that KLOIBER in 1919 discovered that the roentgen diagnosis of intestinal obstruction could be made with great certainty at a very early point of time, without contrast media, only by roentgenologic examination with horizontal direction of the rays. In this manner he revealed the characteristic fluid levels caused by the simultaneous presence in the intestines of gas and thin intestinal contents. The presence of fluid levels in chronic intestinal obstruction had been discovered already in 1911 by SCHWARZ.

KLOIBER published in 1921 100 cases of acute abdomen which had been thus examined. In 77 cases he found intestinal obstruction, in 9 of which this diagnosis was rather unexpected from the clinical symptoms. They were all verified by operation. In the 100 cases he had 2 erroneous diagnoses. In the one case, in which the symptoms had lasted for three hours only, the roentgen examination was negative, while the operation demonstrated the presence of intestinal obstruction. The second case, in which the roentgenologic diagnosis was intestinal obstruction, proved to be a gangrenous appendicitis with paralytic ileus. No less than 13 of the 23 cases with negative roentgen findings, however, were operated upon on the diagnosis of intestinal obstruction on clinical symptoms. In all these cases it was found that no intestinal obstruction was present.

The roentgen diagnosis of obstruction of the small intestine is based in the first instance on the formation of a fluid level in the distended gut. As mentioned above, the condition on which a fluid level may develop is that the intestine simultaneously contains gas and thin intestinal contents.

Greater or smaller quantities of air are constantly present in the colon of a healthy individual, who is up and about. In the small intestine, on the contrary, there is no, or quite insignificant quantities of air. The largest bubbles of gas in the small intestine are of approximately finger's breadth and are generally found in the terminal ileum, originating from the colon. (LAURELL.)

The intestinal gas proceeds partly from swallowed air, partly from fermentative processes in the intestinal tract. In an ambulant person the air which is swallowed down, or the gas liberated in the stomach respectively, will accumulate upwards in the dome of the fundus, and will be forced out again via the esophagus. The duodenum acts as an obstructing fluid lock. It is different in recumbent posture, particularly in the

left lateral position. The pyloric region then is the highest point, and the condition is present for the passage of gas into the small intestine.

AGNUSSON has showed that this actually takes place. He pumped air into the stomach with the patients in recumbent lateral posture. He then found that the air in the form of small bubbles passed the small intestine at great speed. The air took only from 6 to 15 minutes to traverse the entire length of the small intestine, and then accumulated in the cecum and other parts of the large intestine. This explains the colonic meteorism, which may be observed in bedridden patients.

Fluid levels are found *normally* in the stomach and in the pars superior of the duodenum, as also, but more rarely, corresponding to the highest point of the terminal ileal coil. The air bubble at the latter place according to LAURELL is supposed to be due to colonic gas which has passed an insufficient ileocecal valve.

It is necessary to recognize these so-called physiological fluid levels. The gastric fluid level does not usually cause any difficulties on account of its typical position. The levels in the duodenum and downwards into the ileum are short, and also have a characteristic location. Children usually have an insufficient ileocecal valve, and it is particularly here that the lower ileal fluid levels are found. The intestine is not distended, however, and the fluid content is very small (LAURELL).

In the colonic flexures as also in the highest part of the sigmoid great gas bubbles are normally present in standing posture. Fluid levels are not formed on account of the pulpy consistence of the colonic contents. In the presence of diarrhea, however, fluid levels are frequently found, and preferably then at the places mentioned. As a rule it is easily established that these fluid levels lie in the large intestine because of the location and of the haustra in the proximal gas bubbles. The condition of diarrhea *in itself* generally excludes the presence of an intestinal obstruction. In doubtful cases a barium enema will clear up the situation.

In case of meteorism the gas content of the large intestine is increased in the first instance. The small intestine, however, may also be more or less gas-filled. The conditions which are most frequently associated with meteorism are the following: fermentative dyspepsia, which is present most frequently in childhood, severe diseases of infection, particularly pneumonia. Frequently also in a number of cases of acute abdomen, such as attacks of renal colic and biliary lithiasis, acute pancreatitis and torpous intra-abdominal tumours, as also in heart and circulatory deficiencies. (LAURELL.)

When meteorism is present, roentgenologic evidence is found of a gas-distended colon. Inside the colonic frame, corresponding to the small intestine, an irregular mesh is observed of facetted air bubbles, which lie close to each other, separated by narrow septa. If at the same time

there is exudate in the peritoneal cavity, the septa become broader and the gas bubbles rounder (LAURELL).

In the presence of meteorism the fluid content of the small intestine is very small, and one may hardly observe a distinct fluid level. When fluid levels are present they are quite short. The characteristic picture of meteorism is the total clearing up of the entire abdominal region, in which is seen an irregular mesh originating from the intestinal walls.

Fig. 1. Normal (»physiologic«) fluid levels in the stomach, duodenum and terminal coil of the ileum. Pathologic fluid levels of varying length in the small intestine.

When an occlusion takes place of the passage through the small intestine, the immediate result will be an accumulation of thin intestinal contents in oral direction, while the intestine anally to the occlusion is more or less completely emptied. There is increased peristalsis. The intestine makes every effort to pass the obstruction. The tendency to evacuation also includes the colon, which also contracts more or less completely. Not infrequently it may be observed that patients with obstruction of the small intestine have spontaneous defecation shortly after the onset of the pain. In my material this was the case in 7 out of 19 cases. Next comes an abnormal fermentative process of the stagnant intestinal contents with development of gas. This supplies conditions for the formation of fluid levels, which according to KLOIBER commences two or three hours after the onset of the attack.

The length of the fluid levels fluctuates greatly according to the course of the gut. (Fig. 1.) If this is vertical, the length of the fluid level corresponds to the degree of dilatation. If the intestine has a more horizontal course, the length may become considerable. In mechanical ileus the fluid levels are usually visualized in two segments of the same coil at different height, which is due to the intestinal peristalsis. Fluoroscopic examination may demonstrate how the fluid levels rise and fall as an expression of the dilatation and contraction of the intestines, whereby their content is transported from one coil into another. The presence

of this symptom is an important aid in the making of the differential diagnosis between mechanical and paralytic ileus. In paralytic ileus the peristalsis has ceased, and the fluid levels are stagnant (LAURELL).

The fluid surface draws up somewhat along the intestinal wall, the result of which is that the upward limitation has a slightly concave shape. The fluid levels of the small intestine generally lie centrally in the abdomen, a little to the left. The higher up the obstruction is situated the fewer fluid levels — the lower the obstruction the more and lower situated the fluid levels. This is of importanec to the topical diagnosis of the site of the obstruction. — The bubble of air lying above a fluid level in the small intestine is of greater length than height, and Kerkringi folds are frequently observed in the wall. The air bubble above fluid levels in the large intestine is of greater height than length, and in the wall are usually found formation of haustra (KLOIBER).

Fig. 2. (Case no. 7.) Ileus. Male, 13 years of age. 26 hours after the onset of the symptoms. The operation demonstrated obstruction of the ileum 40 centimetres from the ileocecal junction. Note the distended pre-stenotic coil.

The increased fluid content of the pre-stenotic part of the intestine gives an increased general density to the roentgenogram, increasing downwards, the fluid-filled intestines falling down while the gas-filled parts rise. (LAURELL.) When ascites is also present the density of the distal parts will increase further.

The coil of intestine lying immediately proximal to the obstruction, the so-called pre-stenotic coil, frequently presents a peculiar condition. The peristalsis here is particularly strong. The coil rises in the abdomen in the form of a reversed U. It has a stiff appearance, the tonus seems to be stronger than in the other dilated intestines. It is a condition for the visualization of this coil, that it contains abundant gas, which is

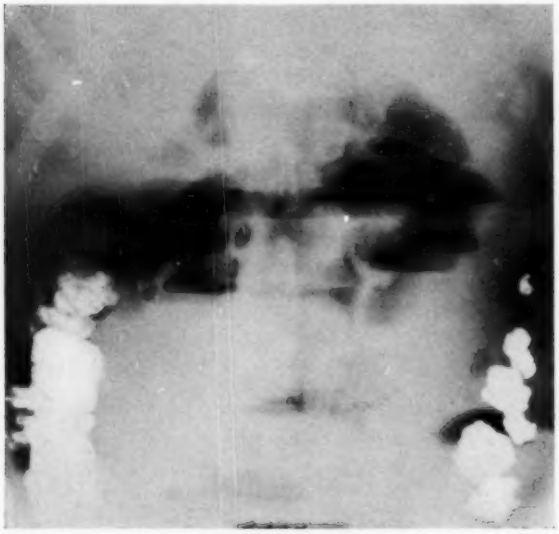

Fig. 3. (Case no. 8.) Ileus. Male, 21 years of age. Contrast enema was given twenty-four hours earlier. Colon contains no gas. Note the marked contraction of the colon wall around the retained contrast. — Operation demonstrated complete obstruction of the ileum 30 centimetres from the ileocecal junction.

remarkably frequently the case. This is the coil which is usually the cause of the clinical visualization of the peristalsis. The location of the pre-stenotic coil is of great value in the diagnosis of the site of the obstruction (Fig. 2).

If an entire coil of the small intestine is shut off from the intestinal tract, both segments being strangulated, this coil becomes greatly dilated by gas and is easily recognizable in the roentgenogram (HINTZE). At the same time this supplies the accurate topical diagnosis, which is represented clinically by the »hypogastric football» (Wahl balloon symptom).

I would also like to mention a roentgenologic symptom which has had only small attention in the literature. In my opinion, however, it is of the greatest importance to the diagnosis. This is the more or less complete absence of gas in the large intestine in the presence of obstruction of the small intestine. This has been a constant finding in my material.

Fig. 3 demonstrates the typical picture of an obstruction of the small intestine. The long fluid levels are observed in the gas-distended coils of small intestine. At the promontory is a long fluid level which indicates a low obstruction of the small intestine. The patient, a man 21 years of age, had had uncertain abdominal symptoms for about 10 days before admission. The fourth day after admission an examination with barium enema revealed nothing pathologic apart from the abscence of filling of the appendix. In the night he had severe abdominal pain, and in the morning vomiting. He was immediately sent for roentgenologic examination, suspected of obstruction. It will be noticed how firmly the large intestine encloses its contents. All colonic gas is absent. In the descending colon the intestinal connection between the contrast spots may

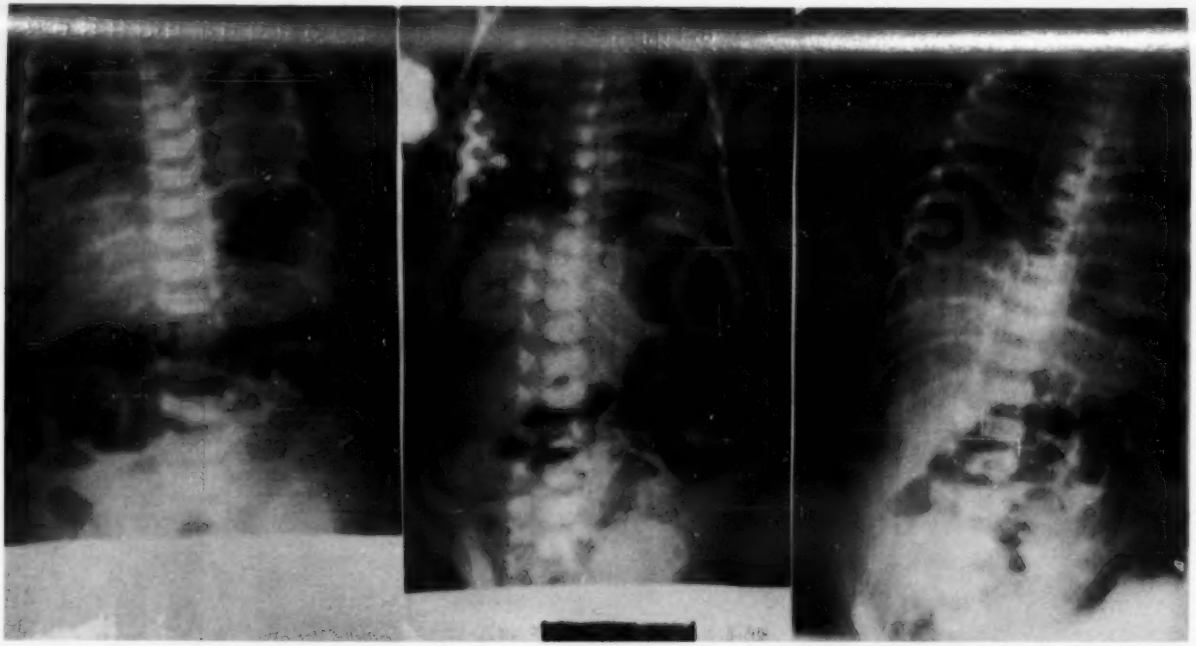

Fig. 4 a. (Case no. 16.) 3 days old infant examined twenty-four hours after the strangulation of a right-sided inguinal hernia. Note the large pre-stenotic coil on the right side. Large gas bubble in the stomach. No gas detected in the large gut.

Fig. 4 b, (Case no. 16.) Half an hour after reduction of the hernia. Gas in the ascending, transverse and descending parts of the colon. The small intestine is still partly distended, containing fluid levels. The pre-stenotic coil has disappeared.

Fig. 4 c. (Case no. 16.) Three hours after the reduction. The large gut is more distended by gas. Some minor gas bubbles in the small intestine, but no fluid levels.

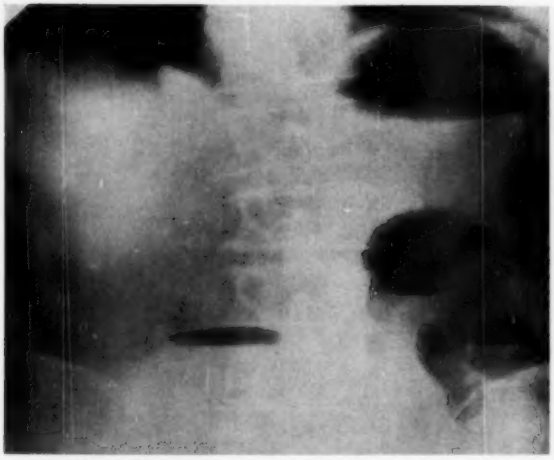

Fig. 5. (Case no. 3.) Ileus. Male, 77 years old. Examined twelve hours after the onset. Broad fluid level in the stomach. Distended small intestinal coils containing fluid levels on the left side. Slightly to the right of the midline a long fluid level with a proximal gas bubble of small height, typical of fluid levels in the small intestine. — No gas in the large gut. — Operation demonstrated complete obstruction of the ileum 20 centimetres from the ileocecal junction.

not even be guessed, and they appear to be lying free in the abdomen. He was operated upon immediately. The operation demonstrated a complete strangulation of the ileum, about 30 centimetres from the ileocecal junction, caused by an adhesion between the tip of the appendix and the omentum.

The following case is a good illustration of the condition of the colonic gas (Fig. 4, a, b, c). An infant, three days old, commenced vomiting. Next day a tumour was found in the right inguinal region. No stools. Roentgenologic examination revealed the picture of a typical obstruction of the small intestine with the pre-stenotic coil on the right side. Colonic air was totally absent. The diagnosis was then assured of strangulated hernia. The hernia was easily reduced. About 15 minutes after the reduction another roentgenologic examination was made, which showed initial gaseous distension of the large intestine. There was still some dilatation of the small intestine with isolated fluid levels. The amount of gas, however, is considerably decreased. Another roentgenologic examination, three hours after the reduction, demonstrated that the gas in the small gut and the fluid levels had disappeared, while a colonic meteorism had come instead.

Fig. 6. Contrast enema examined in standing position after partial emptying. Fluid levels in the colon. Of special interest is the long level in the sigmoid coil. (Arrows.)

In several of the patients suffering from intestinal obstruction I have found an abnormally broad fluid level in the stomach (Fig. 5). This symptom, of course, loses its significance if the patient has eaten or drunk beforehand.

A roentgenogram which demonstrates fluid levels in dilated coils of small gut is pathognomonic of intestinal obstruction. There is great unanimity of opinion on this point in the literature. (ALBRECHT, COOPER, HINTZE, KLOIBER, LAURELL, MARTENS, SAMUELSON.)

In the evaluation of the fluid levels there are not many erroneous sources. — The physiologic fluid levels have already been mentioned. — No doubt the *most important* erroneous source is fluid levels in the large intestine due to retained enema. These fluid levels are located either corresponding to the total diameter of the large gut, or corresponding to the haustra. (Fig. 6.)

It is usually possible to determine that such fluid levels caused by retained enema, are located to the large gut, but they may have a very confusing effect. If the enema has been a large one, and has been injected

with the container raised high, the possibility is present that the enema together with colonic gas may pass the ileocecal valve and penetrate into the ileum, with the result that fluid levels are formed. It is of paramount importance, therefore, that the patients are not given enemas before the roentgenologic examination. — It is difficult to decide for how long this erroneous source persists. In the present material 7 of the patients suffering from intestinal obstruction had been given enemas at home, as much as three hours before the examination, without any fluid levels having been demonstrated in the large gut. At the same time, however, it should be kept in mind that in the presence of intestinal obstruction there is an increased tendency to evacuation in the part of the intestine distal to the obstruction, so that the enema returns more quickly and more completely.

Fluid levels are found in *paralytic ileus* as well as in mechanical ileus. At first a meteorism only is found, which is chiefly localized to the large gut. In the fully developed paralytic ileus, however, fluid levels are formed in the small gut in complete correspondence with the findings in mechanical ileus. — In paralytic ileus, however, one will always find a meteoristic large intestine, which is never the case, according to my investigations, in an obstruction of mechanical nature.

Mixed forms of paralytic and mechanical ileus may occur in intraperitoneal abscesses, particularly in appendical abscesses. An appendical abscess may cause a true mechanical ileus. (PLATOU.) In such cases it may present the roentgenologic picture of a mechanical ileus (SEMB).

Embolism and *thrombosis* of the mesenteric vessels present the typical picture of intestinal obstruction, which is impossible, it is said, to distinguish from a true ileus (LAURELL). This erroneous source has less practical importance, as the indication of operation is absolute in these cases also.

In *enterocolitis* associated with diarrhea, fluid levels may be found in the large intestine, as has been mentioned before.

In *regional* (*terminal*) *ileitis* distended intestines with fluid levels may be found just above the affected gut (POLGAR). In these cases, however, a stenosis has taken place of the affected intestine with a more or less pronounced obstruction of the intestinal passage. As this lesion also necessitates immediate surgical treatment due to the risk of perforation, the problem of differential diagnosis as against a true mechanical ileus is of no great importance.

Gas-forming abscesses in the peritoneal cavity may also produce bubbles of gas lying above fluid levels. This is seen most frequently in the subphrenic abscesses. It may occur also in appendical abscesses, however. As a rule it is distinctly noticeable that the fluid level and the gas do not lie in the intestinal tract. LAURELL has suggested a number of characteristic roentgenologic symptoms of encapsuled intra-peritoneal abscesses.

Fig. 7. (Case no. 21.) Sigmoid volvulus. Female, 69 years old. The greatly distended gut has just been emptied of its fluid contents with the aid of a rubber tube inserted through a rectoscope.

KLOIBER, and particularly LAURELL, have examined a great number of acute abdomens other than intestinal obstruction, as also lesions accompained by pronounced meteorism, and have never found the characteristic fluid levels in other lesions than intestinal obstruction. My investigations also corroborate this.

Obstruction of the large intestine has also a very characteristic roentgenogram, which is distinguished by distension and formation of fluid level in the part of the large intestine proximal to the obstruction. If the passage is completely obstructed the distension may become enormous. At the onset of an obstruction of the large intestine there is no roentgenologic changes in the small intestine. (MARTENS, LAURELL). This is generally the case in sigmoid volvulus. If there is fluid levels in the small

Fig. 8. Constipation. Male, 27 years old. Acute abdominal pain and vomiting. A mechanical ileus was suspected from the clinical symptoms. — The bowel is filled by shadow-producing fecal material. No gas in the small intestine. A bullet in the right lumbar muscles. Cured by enemata.

gut in this lesion, LAURELL takes this as a proof of a peritonitis having developed. — In volvulus of the sigmoid there is an extreme dilatation of the sigmoid coil, which fills the entire central part of the abdomen, and may reach as far upwards as the diaphragm (Fig. 7). As a rule fluid levels are found downwards in both segments of the coil. In obstruction caused by a stenosing tumour in the large intestine the distension may be very moderate at first.

Not until an obstruction of the large gut has been present for a considerable time will the X-ray evidence of ileus spread to the small gut as well. As mentioned before this is also the case if there is a simultaneous peritonitis.

A *pseudo-ileus* resulting from constipation is generally easily recognizable on the roentgenogram (Fig. 8). A meteoristic colon is revealed containing copious scybala, appearing on the roentgenogram as positive shadows. On administration of a barium enema scybala form irregular filling defects.

The question now arises: Are the characteristic fluid levels always present in obstruction of the small intestine? Or — in other words — how frequently will the suggested method of examination fail? — According to KLOIBER one cannot expect to find fluid levels until after the attack has lasted for two to three hours, and the following two-three hours there will always be a factor of uncertainty. There is little information available on this point. A thorough study of strangulated hernias, which usually come in early for operative treatment, would bring light on this matter. Some authors maintain that it may occasionally be difficult to demonstrate the fluid levels. Apart from the case referred by KLOIBER, in which the symptoms have lasted for three hours only, I have not been able to find reports of any cases of intestinal obstruction examined in the suggested manner, where the roentgenogram has been negative.

The earliest diagnosis of intestinal obstruction in my material was made 9 hours after the onset of the attack. The roentgenologic changes were vague, but sufficiently distinct for the diagnosis to be made of obstruction of the small intestine.

The patient was a woman, 52 years of age. Previously she had been healthy on the whole. She had been somewhat constipated for a long time. Last motion about 12 hours before she became ill. About 9 hours before admission acutely ill with pain over the entire abdomen, diffuse, aching, strongest in the epigastrium. Seven hours after the onset of the pain she had two vomitings. No passage of feces or flatus. No need for passage of flatus, however. No feeling of oppression. Examination on admission showed: Temperature 37.6° C. Pulse 64. The tongue moist, somewhat coated. *Abdomen:* No meteorism. No ascites dulness. Soft everywhere. Slight tenderness on pressure in the epigastrium and below the right costal arch. No palpable filling. Vaginal exploration: Normal conditions. Urine: Heller, KOH, Guajak, Haine — all negative. Microscopical examination showed a few red corpuscles. She was immediately referred for roentgenologic examination (Fig. 9). Survey roentgenogram in erect position showed locally gas-filled, slightly dilated coils of small intestine on the left side. In one of the coils appeared a distinct fluid level. In the right iliac fossa one separate gas bubble was lying above a short fluid level in the small intestine. Large gas bubble in the stomach, but no fluid level. *No air demonstrable in the colon.* Distinctly increased density downwards in the abdomen. A barium enema was then given, revealing a contracted colon without content of gas. After evacuation of the contrast enema another survey in erect position demonstrated somewhat more distinctly the fluid levels in the small intestine.

Clinically there were few data on which to diagnose intestinal obstruction. On account of the roentgenologic findings, however, she was operated on immediately. The operation demonstrated a medium quantity of clear, serous fluid in the peritoneal cavity. About 50 centimeters from the ileocecal junction was found a moderately dilated, approximately 30 centimetre long coil of small intestine which was strongly discoloured due to diffuse subperitoneal hemorrhage. The whole of this coil of gut was completely strangulated by a filiform adhesion, which proceeded from the internal genitals and coiled round the mesenteric attachment.

The suggested method of roentgenologic examination has found use with continually increasing frequency at the Surgical Department of

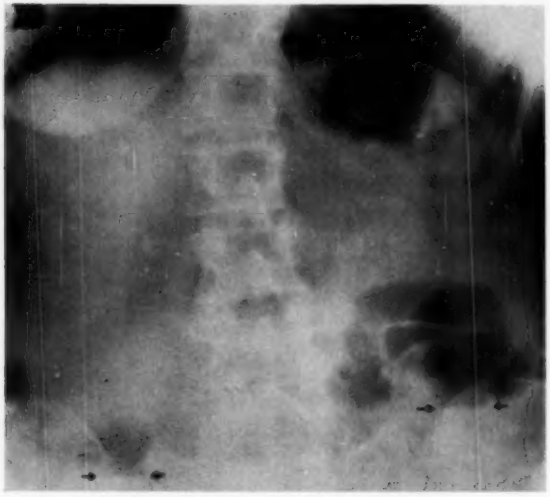

Fig. 9. Ileus. Female, 52 years old. Examined nine hours after the onset of the pain. Operation demonstrated obstruction of an ileal coil 50 centimetres from the ileo-cecal junction.

Aker Municipal Hospital since January 1937, and is used now in all abdominal cases suspected of intestinal obstruction. From January 1st 1937 to April 16th 1938 a total number of 26 cases of intestinal obstruction have been treated, 21 of which have been examined roentgenologically. — The material comprises a total of 46 cases of acute abdomen. (See table 1.) In all the cases the roentgenologic examination has supplied a correct reply as to whether intestinal obstruction has been present or not.

Of the 21 cases of intestinal obstruction there were 12 men and 9 women. — 8 patients were admitted in the course of the first twenty-four hours. A total of 15 had been admitted before forty-eight hours had elapsed. 10 of the patients had been operated on previously. — 18 patients had had vomitings. Two of these patients had distinctly fecal, and two more doubtfully fecal vomitings. — Distinct meteorism was found in 8 cases, and in a further 7 cases slight meteorism. (15 in all.) — Distinct ascites dulness was found in 7 cases, uncertain in 5 cases (12 in all). Information of delayed defecation and flatus was given in 11 cases. In 3 cases enemas had been effective, but no spontaneous defecation. (A total of 14 cases.) Increased non-protein nitrogen in the blood (more than 50 milligramme per cent according to the Yvonne test) was present in 4 of 11 patients.

Table 1.

Diagnosis	Number	Operated	Cured	Died
Strangulation ileus	12	12	10	2
Ileus. Strangulated intra-peritoneal hernia	1	1		1
» Strangulated inguinal hernia, reduced en masse	2	2	2	
» Invagination (Meckel's diverticula and iliac ileocolic)	1	1	1	
» Strangulated inguinal hernia (3 days old infant)	1		1	
» Tumour of the sigmoid	1	1	1	
» Volvulus of the sigmoid	1		1	
Sub-ileus	2	1	2	
	21	18	18	3
Acute catarrhal appendicitis	1	1		
» gangrenous »	2	2		
» perforated gangrenous appendicitis	2	2		
Peritonitis. Typhlitis circumscripta	1	1		
Colic	7	2	(appendectomy)	
Colic. Constipation	1			
Abdominal retention of testicle	1			
Perforated ulcer (gastric and duodenal)	2	2		
Gastric ulcer, threatening perforation	1			
Ectopic gestation	1	1		
Acute cholecystitis	2			
Nephrolithiasis	2			
Enteroptosis. Hysteria	1			
Spastic colitis	1			
	46	29		

Of the total of 26 cases of intestinal obstruction 3 have died. 23 have been operated on, and 3 have been discharged as cured without operation. If this is calculated percentally, the total mortality is 11.5 per cent — and 13 per cent for the operated cases.

In comparison I have studied the material of intestinal obstruction from the Surgical Department of Aker Municipal Hospital for the period July 1st 1924 to December 31st 1936 ($11^1/_2$ years). During this period 116 cases of intestinal obstruction have been treated, 97 of which have been operated on. The total mortality for the whole material is 39 per cent — and 38 per cent for the operated cases. Only about half the cases in this material have been operated on immediately after admission, while in the present material this has been the case in 19 of 23 cases.

It is not permissible, of course, to compare the small group of 26 cases with the larger group of 116 cases. It should be permitted, however, to take it that the results have been essentially improved after the roentgenologic examination has been adopted as routine procedure, and that

Table 2

Data with Regard to the Ileus Patients

Case No.	Admission Diagnosis	Sex & Age	Duration of disease	Previous Operation	Vomitings	Fecal vomitus	Meteorism	Ascites	Delayed defecation & flatus	Non-protein nitrogen in blood	
1.	Acute abdomen	M. 22	31 hours	Yes	+	?	—	—	Enema +	60 mg. per cent	
2.	Ileus	M. 60	30 »	»	+	—	Faintly +	—	+	—	
3.	Abdominal pain	M. 77	12 »	No	+	—	» +	?	—	35 mg. per cent	
4.	Acute abdomen	M. 23	40 »	Yes	+ +	—	» +	+	+	50 » » »	
5.	Colic. Ileus?	F. 43	20 »	»	+ +	+	+	—	—	45 » » »	†
6.	Acute abdomen	M. 13	24 »	»	+ +	—	—	?	+	—	
7.	Ileus	M. 13	26 »	»	+	—	Faintly +	+	?	20 mg. per cent	
8.	Acute appendicitis	M. 21	96 »	No	+	—	+	+	—	40 » » »	†
9.	Ileus?	F. 70	96 »	»	+	+	+	+	Enema +	80 » » »	†
10.	Strangulated hernia	M. 42	30 »	»	+	—	Faintly +	?	+	—	
11.	Acute abdomen	M. 58	32 »	Yes	+	?	—	+	+	35 mg. per cent	
12.	Ileus	M. 5½	180 »	No	+	—	+ +	—	+	—	
13.	Intestinal occlusion	F. 60	120 »	»	+	—	+ +	+	+	—	
14.	Sub-ileus?	M. 25	72 »	Yes	—	—	—	?	—	55 mg. per cent	
15.	Acute abdomen. Ileus?	F. 50	24 »	»	—	—	Faintly +	?	+	50 » » »	
16.	Strangulated hernia	M. 3 d.	24 »	No	+	—	+	—	+	—	
17.	Acute abdomen	F. 38	9 »	»	+	—	Faintly +	—	Enema +	—	
18.	Ileus	F. 37	15 »	Yes	+	—	+	+	+	50 mg. per cent	
19.	Strangulated hernia	F. 71	34 »	No	+	—	—	—	—	—	
20.	Acute abdomen. Ileus?	F. 52	10 »	»	+	—	—	—	—	—	
21.	Sub-ileus?	F. 69	60 »	»	—	—	+	—	+	—	

Fig. 10. (Case no. 4.) Ileus. Male, 23 years old. Examined forty hours after the onset. Broad fluid level in the stomach. The small intestine contains amounts of gas. Fluid levels in the distal parts. Note the typical location of the gas bubbles in the middle of the abdomen, slightly more on the left side. To the extreme right the maximally contracted ascending colon may be seen indistinctly. In the other parts of the colon gas is absent.
Operation demonstrated obstruction of the ileum 15 centimetres from the ileocecal valve.

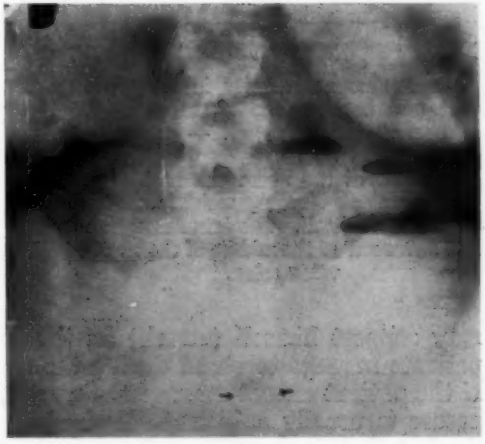

Fig. 11. (Case no. 5.) Ileus. Female, 43 years old. Examined twenty hours after the onset. Three fluid levels on the left side. One indistinct level (arrows) corresponding to the 5th lumbar vertebra, indicating an obstruction of the lower ileum. Compact density in the lower part of the abdomen, especially in the pelvic cavity, caused by increased peritoneal fluid and increased fluid contents proximal to the obstruction. Operation demonstrated obstruction of the ileum 35 centimeters from the ileocecal valve.

the improvement may be ascribed to the earlier diagnosis leading to earlier operation. The treatment has been indentical in both groups.

Technique

The patient is placed in erect position as for a gastric examination. As the entire examination occupies a few minutes only, and the patient

Fig. 12. (Case no. 12.) Intussusception. Boy, $5^1/_2$ years old. Examined seven and a half years after the onset. Typical picture of obstruction of the small intestine. Compact density in the pelvic part and between the intestinal coils. No gas in the large gut. — Operation demonstrated an intussusception of the lower part of the ileum caused by the diverticula of Meckel, which was invaginated in itself. The intussusception had advanced of the middle of the transverse colon.

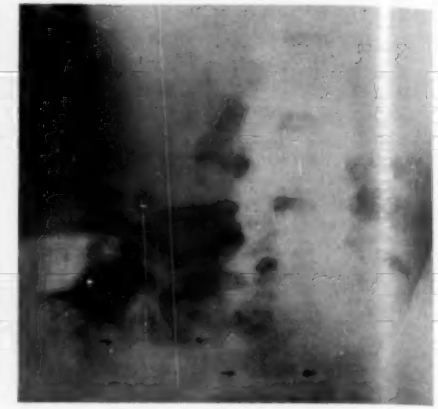

Fig. 13. (Case no. 10.) Strangulated inguinal hernia (on the right side), reduced en masse. Examined thirty hours after the onset, and three hours after the »reduction». Distended small intestine on the right side, containing fluid levels. No gas in the bowel.

may support himself (herself) on the roentgen frame, the majority of patients manage to stand during the short time the examination lasts. If the patient cannot manage the erect position, a lateral recumbent exposure is usually sufficient. Right lateral recumbency is best, due to the fact that the left side of the abdomen contains the most coils of small intestine.

Fluroscopic examination as well as roentgen examination are used. During the fluroscopic examination the movements of the diaphragm are observed, and search is made for exudate in the phrenic-costal sinus. If fluid levels are present, which fact is usually evident already during the fluoroscopic examination, it is necessary to watch whether they fluctuate as a result of peristaltic waves, or whether they are stagnant.

The exposures are made as for gastric examinations. We have used the Lysholm secondary diaphragm. When this is used care must be taken that the stripes are placed vertically, for the reason that horizontal stripes on the roentgenograms may form false fluid levels.

If the interpretation of the roentgenogram in erect position is difficult the evaluation is facilitated by a supplementary exposure in supine position with vertical direction of the rays. This brings the colon more distinctly to the fore, and the degree of dilatation of the small intestine is also seen more easily. It may also be useful to observe the condition of the fluid levels in lateral recumbency.

Fig. 14. (Case no. 6.) Ileus. Male, 13 years of age. Examined twenty-four hours after the onset. Broad fluid level in the stomach. Pronounced distension of the small intestine with fluid levels. The lower coil is probably the pre-stenotic coil. Note the contracted ascending and transverse colon on the right side. Operation demonstrated strangulation of an ileal coil 5—20 centimetres from the ileocecal valve.

In erect position an exposure in the first oblique position may occasionally reveal the condition of the small intestine more distinctly than in the antero-posterior position. (Fig. 17, a and b.) Exposures in lateral erect position, however, have supplied no further information worth mentioning.

Peroral administration of contrast has not been used in any case. As a rule this forbids itself on account of the vomitings. This examination also takes a long time, and is very troublesome to patients, on account of the repeated examinations. Further, there is the risk — if an intestinal obstruction is present — of loading up a gut which is already beforehand distended. In my opinion this examination should be reserved for cases suspected of intestinal obstruction, who have a negative survey picture, and in whom the clinical symptoms are not very fulminating. Small quantities of contrast should then be used, i. e. 1—2—3 tablespoonfuls.

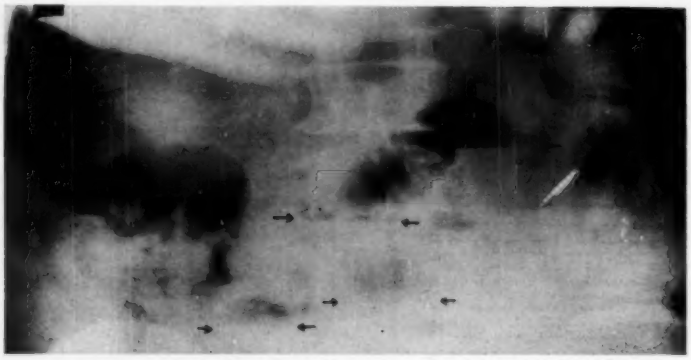

Fig. 15. (Case no. 2.) Ileus. Male, 60 years old. Examined thirty hours after the onset. Distension of the small intestine with several fluid levels of varying length. The bowel contains shadow-producing fecal material, but very little gas. Compact density, in the pelvic region. — Operation demonstrated several cord-shaped adhesions to the ileum 50—80 centimetres from the ileocecal valve, one of them strangulated the gut completely.

The roentgen diagnoses of intestinal obstruction

As a rule the survey picture in erect position has been convincing. In several cases supplementary exposures have been made in lateral and oblique erect position, as also in supine position.

In two cases barium enema has been given, which has immediately been extracted again with a probe introduced. (Cases 20 and 21.)

It has been established in all cases whether an obstruction of the small or of the large intestine has been present. — In a number of cases it has been possible to state roughly the site of the obstruction. In one case this statement was erroneous, the roentgenologic findings pointing to a high intestinal obstruction, while it was proved that a low intestinal obstruction was actually present. (Case 19.)

18 of the 21 roentgen diagnoses of intestinal obstruction were confirmed by operation. — For the remaining three the conditions were as follows:

1. *Strangulated hernia* in an infant, 3 days old. (Case no. 16 — fig. 4.) After reduction of the hernia the intestinal function was restored.

2. *Sub-ileus.* (Case no. 11.) This patient had had symptoms of typical intestinal obstruction for 32 hours. When he was being taken to the hospital these symptoms ceased suddenly, and he had abundant spontaneous defecation with passage of flatus. — Roentgenologic examination immediately after admission revealed moderately distended small intestines with a few short fluid levels. Moderate gaseous distension of the large intestine. In the course of the subsequent twenty-four hours there was restoration of the normal

Fig. 16. (Case no. 9.) Ileus. Female, 70 years old. Examined four days after the onset. The coil in the right iliac fossa is probably the pre-stenotic coil. The oblong gas bubble under the left costal arch is supposed to be in the left flexure of the colon. Gas in the other parts of colon is absent. — Operation demonstrated incarceration of the terminal ileal coil in an intra-peritoneal hernia in the right iliac fossa.

intestinal function with complete absence of symptoms. Another survey picture showed that the roentgen symptoms of intestinal obstruction had now disappeared completely.

3. *Sigmoid volvulus.* (Case no. 21 — fig. 7.) The patient was an insane woman, 69 years of age, extremely debilitated. She had been ill for sixty hours with moderate symptoms of intestinal obstruction. Her relations did not desire operation. — With a thick gastric probe, introduced with the aid of a rectoscope, the dilated coil of intestine was successfully emptied. The intestinal function was restored after this intervention had been carried out twice.

The two cases of strangulated inguinal hernia reduced en masse, deserve special mention.

1. (Case no. 10.) The patient, a man 42 years of age, had had right-sided inguinal hernia for 2 years. About 30 hours before admission he had symptoms of strangulation. The physician called in reduced the hernia. The reduction was very arduous and took about 30 minutes. He was afterwards free from pain for three hours. Then again abdominal pain and vomitings. The hernia was now *easily reduced*, however. This was also the case on admission. Roentgenologic examination (fig. 13) revealed distended coils of small intestine on the right side of the abdomen with several fluid levels, up to 5 centimetres in length. There was no colonic air except for a couple of small air bubbles in the right flexure. Roentgen diagnosis: Obstruction of the small intestine, probably near the ileocecal junction. The subsequent operation demonstrated that there was a reduction en masse.

2. (Case no. 19.) The patient, a woman 71 years of age, had had inguinal hernia for many years. About 34 hours before admission she had symptoms of strangulation.

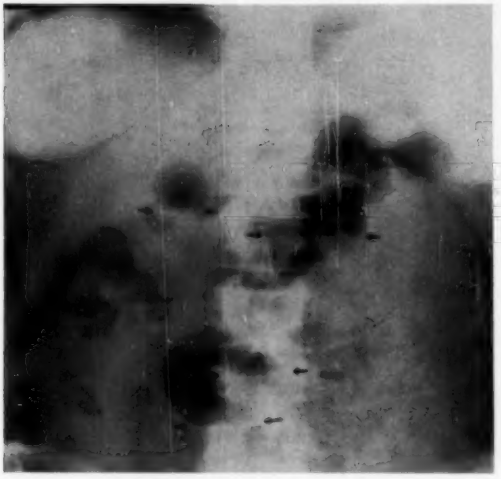

Fig. 17 a. (Case no. 15.) Ileus. Female 50 years old. Examined twenty-four hours after the onset. Multiple gas bubbles and fluid levels in the small intestine. Colonic gas is completely absent.

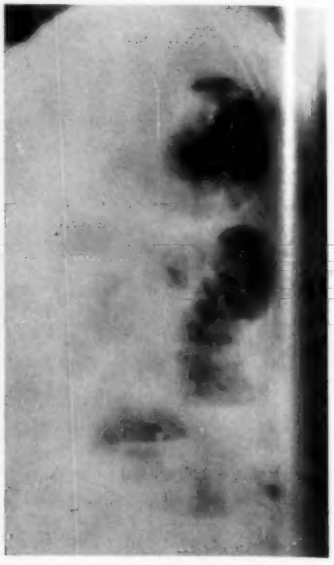

Fig. 17 b. (Case no. 15.) Same patient photographed in slightly oblique position (1st position). The distended small intestine and the fluid levels appear more clearly. — Operation demonstrated strangulation of the ileum caused by old adhesions from an appendectomy scar.

The physician called in succeeded in reducing the hernia partly, but not completely. The symptoms persisted. On admission an inguinal hernia was found, the size of a tangerine, which was irreducible. Roentgenologic examination just after admission showed: Distinct increase of the density in the abdomen. Broad fluid level in the stomach. Upwards on the left side of the abdomen were observed several fluid levels in dilated coils of small intestine. *Otherwise no gas present in the abdomen.* Colonic gas is completely absent. Roentgenologic diagnosis: Obstruction of the small intestine, probably a high obstruction. — The subsequent operation demonstrated a reduction en masse in this case as well, the inmost part of the inguinal sac having been reduced together with the strangulated intestine.

The roentgenologic examination, therefore, may be used in deciding whether a strangulated hernia contains intestine, and whether there has been a false reduction or not. In the latter case the conclusions must be drawn with the greatest care, due to the fact that the roentgenologic symptoms of intestinal obstruction usually persist for some time after

the obstruction has been relieved. It cannot be stated with certainty how long this lasts. In the one case which I have had the opportunity of following up, (case 16), the roentgenologic signs of intestinal obstruction had disappeared completely three hours after the obstruction was relieved.

Re the »negative» diagnoses

In two cases of peritonitis a few short fluid levels were found in the small gut. In both these cases, however, a considerable colonic meteorism was present. In one case (nephrolithiasis) an enema fluid level was found in the descending colon. — The other cases have been convincingly negative.

It is my opinion that I am justified in concluding with the statement that the roentgenologic examination described above is the best aid at disposal in the diagnosis of intestinal obstruction. Roentgenologic examination elucidates in a short time whether an intestinal obstruction is present or not, and whether it is located to the small or the large intestine. In a number of cases of intestinal obstruction accurate information is obtained as to the site of the obstruction.

The roentgenologic changes occur early — the percentage of errors appears to be very small — and the entire examination occupies a few minutes only.

SUMMARY

The author describes the roentgenologic symptoms of intestinal obstruction (without contrast media). The significance of the amount of gas in the colon is strongly stressed. Problems of differential diagnosis are discussed. Next are reported 46 acute abdominal cases suspected of intestinal obstruction. In all cases the roentgen examination supplied a correct reply as to whether or not an intestinal obstruction was present. In a majority of cases the accurate site of the lesion could be given roughly. — The mortality of intestinal obstruction at Aker Municipal Hospital has decreased considerably subsequent to the adoption as routine method of the roentgen examination of abdominal cases suspected of intestinal obstruction. — The author states that the roentgen examination is the best aid at disposal in the diagnosis of intestinal obstruction.

ZUSAMMENFASSUNG

Verf. beschreibt die durch Röntgenuntersuchung ohne Kontrastmittel erhaltenen Symptome der Darmobstruktion und betont dabei nachdrücklich die Bedeutung der im Kolon vorhandenen Gasmenge. Es folgt eine Erörterung differentialdiagnostischer Probleme, und dann ein Bericht über 46 akute Abdominalfälle, bei welchen Verdacht auf intestinale Obstruktion bestand. In allen Fällen lieferte die Röntgenuntersuchung eine korrekte Antwort auf die Frage, ob intestinale Obstruktion vorliegt oder nicht. In der

Mehrzahl der Fälle konnte der genaue Sitz der Affektion annähernd angegeben werden. — Auf Einführung einer regelmässig zur Anwendung gebrachten Röntgenuntersuchungsmethode für Abdominalfälle, die auf Darmobstruktion verdächtig waren, hat sich die Mortalität an Darmobstruktion am städtischen Krankenhause in Aker beträchtlich verringert. — Verf. bezeichnet die Röntgenuntersuchung als das beste Hilfsmittel, das zur Diagnose von Darmobstruktion zur Verfügung steht.

RÉSUMÉ

L'auteur décrit les symptômes roentgenologiques de l'obstruction intestinale (sans emploi de contrastes). La signification de la quantité de gaz dans le côlon est fortement soulignée. L'auteur discute des problèmes du diagnostic différentiel. Il rapporte ensuite 46 cas abdominaux aigus, suspectés d'obstruction intestinale. Dans chacun des cas, l'examen roentgen fournit une réponse correcte au sujet de savoir s'il y avait obstruction intestinale ou non. Dans la majorité des cas, l'emplacement exact de la lésion put être approximativement indiqué. — La mortalité de l'obstruction intestinale, à l'Hôpital Municipal d'Aker, a considérablement décrû depuis l'adoption comme méthode courante de l'examen roentgen dans les cas abdominaux suspectés d'obstruction intestinale. — L'auteur établit que l'examen roentgen constitue la meilleure aide disponible pour le diagnostic de l'obstruction intestinale.

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DOSAGE, DURATION OF TREATMENT AND REACTIONS IN PROTRACTED-FRACTIONAL ROENTGEN TREATMENT, WITH SPECIAL REFERENCE TO CARCINOMA OF THE UPPER AIR PASSAGES[1]

by

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Chart 1:

Total Number of Cases referred, and Numbers still symptom-free in 1937

Referred:	1931	1932	1933	1934	1935	Total
Hypopharynx (extrinsic Larynx)	10—2	14—3	14—6	11—1	9—1	58—13 = 22 per cent
Rhinopharynx	5—3	2—0	7—2	7—3	7—1	28— 9 = 32 » »
Tonsil	5—2	9—2	4—1	7—1	6—3	31— 9 = 29 » »
Base of tongue	4—0	1—1	4—1	1—1	2—0	12— 3 = 25 » »
Larynx (intrinsic)	2—0	1—0	6—2	7—2	6—3	22— 7 = 32 » »
	26—7	27—6	35—12	33—8	30—8	**151—41 = 27** per cent

In the years 1931—1935 there were referred to the Radium Centre in Copenhagen, in all, 151 cases of malignant epithelial tumors (sarcomas not included) of the hypopharynx, rhinopharynx, tonsil, base of tongue and larynx. Of these, 41 (= 27 per cent) remain apparently cured in 1937. The cases free of symptoms are fairly equally distributed over the different years and among the different localisations. The therapy has been protracted-fractional roentgen treatment, only in 3 cases of tonsil cancer supplemented by radium and in 1 by electrosurgery. The absolute cure rate is:

[1] Read before the V[th] International Congress of Radiology, Chicago, 1937.
This paper has already appeared in »*Radiology*». The editor of Acta Radiologica has nevertheless felt it desirable to publish it again in order to make the last work of JENS JUUL known in Scandinavia and thus to honour his memory.

Chart 2:

Absolute Cure Rate

After at least	1 year	45	of 151	(= 30	per cent)
	2 years	35	of 121	(= 29	» »)
	3 »	25	of 88	(= 28	» »)
	4 »	13	of 53	(= 25	» »)
	5 »	6	of 26	(= 23	» »)

For details of the treatment I must refer to a paper af mine in the Acta Radiologica for 1936 (vol. XVII., p. 209). The dosage has been mainly according to clinical criteria; while the physical dose — both daily dose, total dose and treatment time — has varied considerably.

Chart 3:

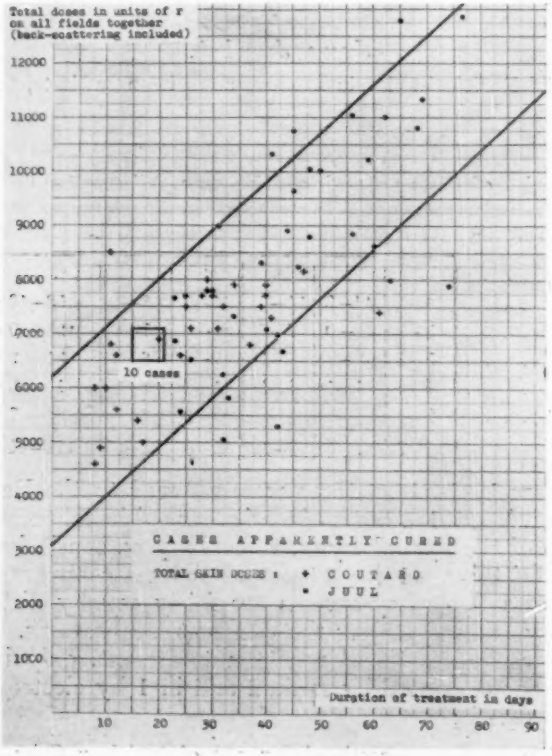


Chart 3 shows the symptom-free cases plotted in a co-ordinate system; the duration of the treatment (in days) being marked along the abscissa,

th total dose on all fields together (back-scattering included) along the or inate. The dots represent our own patients, the crosses patients from Co TARD's reports. In the small square are 10 of COUTARD's patients. Ei hty-six per cent of the cases lie within a zone whose width corresponds to a variation in dose of 3,000 *r*. This zone extends diagonally upward tr gh the field in such a manner that to a longer treatment time there co esponds a larger dose. For each additional day of treatment time the do e is increased by about 90 *r*. To a dose of 6,000 *r* in 20 days corresponds a ose of 6,900 *r* in 30 days, 7,800 *r* in 40 days, and soforth.

Chart 4:

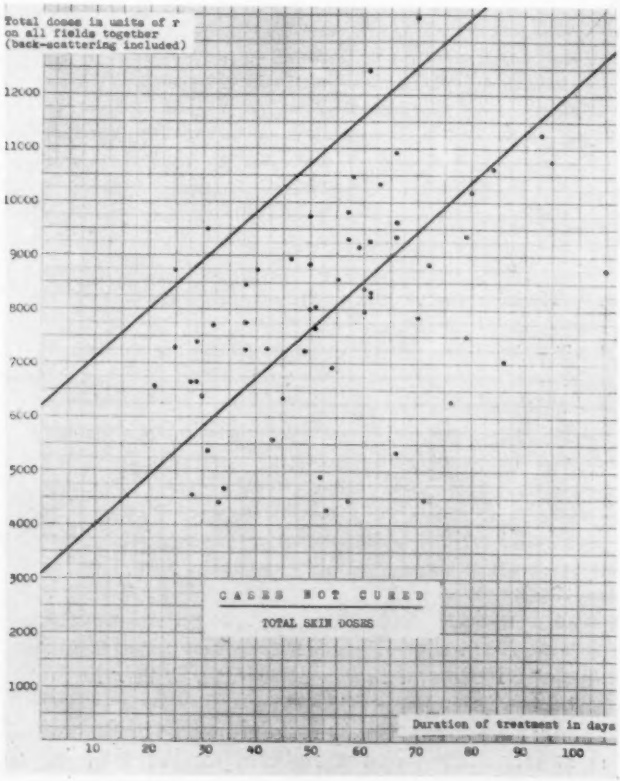
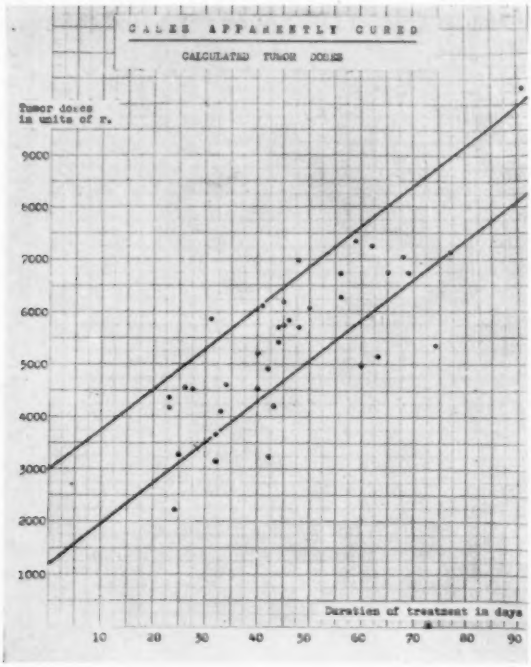


Chart 4 shows the cases not cured which received over 4,000 *r*, plotted in the same manner as those in the preceding chart. They lie considerably m re scattered; only 46 per cent lie in the »favorable» zone, 52 per cent

below the inferior border line. A cure has thus only in exceptional cases been obtained with doses of less than 4,900 *r* in 20 days, 5,800 in 30, 6,700 in 40, 7,600 in 50, or 8,500 *r* in 60 days. At the same time, the 8 per cent of cases not cured which lie above this border line show that though a dose of higher value than these may perhaps be a necessary condition for obtaining a cure it is, of course, not sufficient to *ensure* it.

Chart 5:



Next, I have calculated the dosis in the tumor itself, for my own symptom-free cases, and plotted them in the same manner. It will be seen that most of them lie within a zone whose width corresponds to a variation in dose of 1,800 *r;* and again we see how the doses increase with the duration of treatment.

It seems to me that the necessity for an increase of dose when the treatment period is lengthened has a natural explanation in the possible capacity for recovery of the cancer cells from the ray lesion; and I have therefore tried to find out how these experiences may be made to fit with KINGERY-PFAHLER's theory concerning this recovery. As you know, the elimination of the »ray poison» from the tissues, according to this

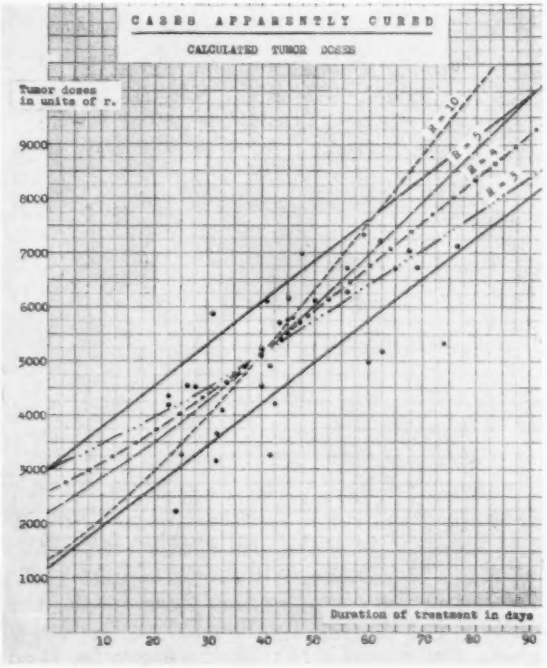
theory, follows a logarithmic curve; the speed of the elimination being at any given time proportional to the concentration of the »ray poison» at the moment. The total doses which, if distributed evenly over a varying number of days should produce the same effect, — or, to keep to the analogy of the »ray poison»: the same concentration in the tissues, can be calculated by means of the following formula:

Chart 6:

$$D_p = D_n \times \frac{p}{n} \times \frac{1-(1+R)^{-n}}{1-(1+R)^{-p}},$$

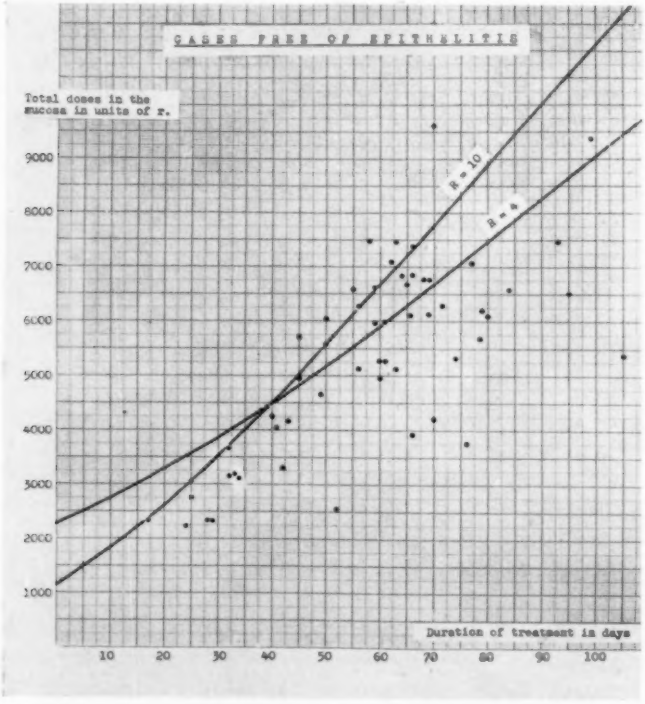
In which R is the rate of recovery per day, and D_p the total dose which distributed equally over p days gives the same effect as the dose D_n, if the latter is distributed equally over n days. The calculation will only be exact if the daily doses given have all been of the same magnitude. In my cases they have only been so approximately.

Chart 7:



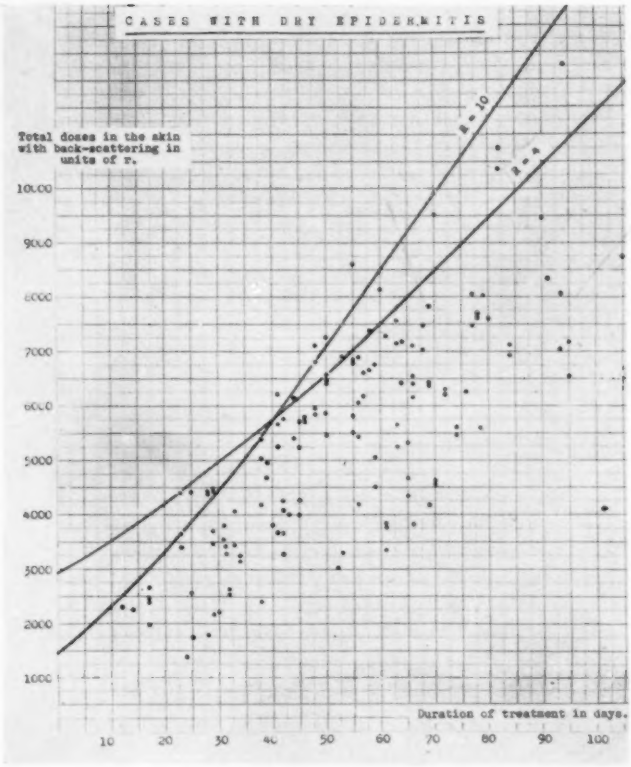
I have started from the dose 5,100 *r* in 40 days as values for D_n and n, as that is one of the best determined points; and have from there figured out D_p for various values of p and R. As the chart shows, the curve for the recovery rate equal to 4 per cent is the one whose course corresponds best with the values that were found empirically. The application of KINGERY-PFAHLER's theory in regard to recovery after ray lesion thus leads to the acceptance of a recovery rate for tumor cells of about 4 per cent per day.

Chart 8:



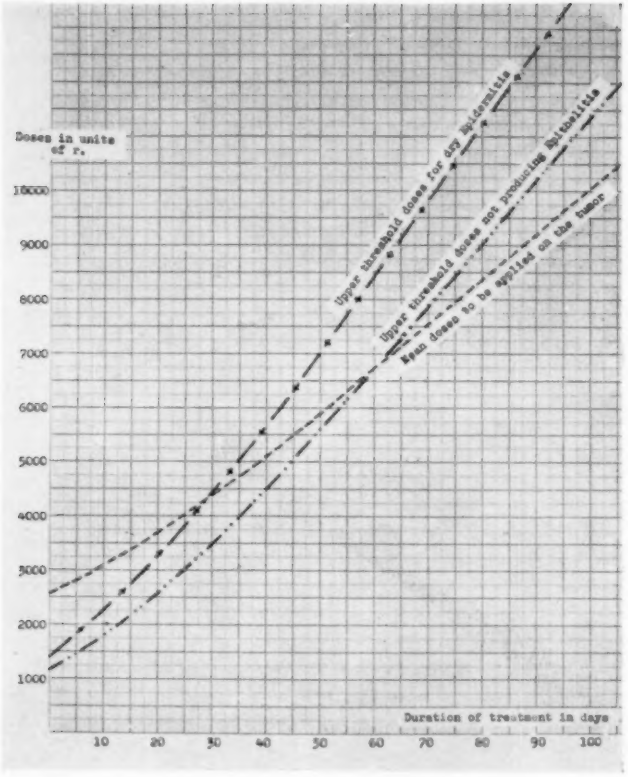
In a similar manner I have plotted the doses which we in our cases have been able to apply to the sound mucosa without provoking epithelitis. With the use of the same formula, and starting from the dose 4,500 *r* in 40 days as one of the best determined points of the upper margin, I have constructed the curves for corresponding doses for R = 4 and R = 10. It will be seen that the threshold values for production of epithelitis in the sound mucosa correspond best with the curve for R = 10 or more.

Chart 9:



Finally, I have in Chart 9 plotted down the empirically found doses which had been applied to the skin of those patients who did not get exudative, but only dry epidermitis. In calculating the doses, both the back-scattering and the dose through the neck from the other side have been taken into account. In the theoretical calculation of the corresponding doses under different rates of recovery, we have started from the dose of 5,700 *r* in 40 days. It will be seen that also here a recovery rate of 10 per cent per day is the one which corresponds best with the practical experience.

C h a r t 10:



In Chart 10 I have set down together the three curves before determined; namely, the curves for the upper threshold doses for dry epidermitis, for the upper threshold doses not producing epithelitis and for the mean values of the necessary tumor dose. If we look at how the curves lie in relation to each other, we see that with a treatment time of less than 3 to 4 weeks it is not possible to make a tumor of medium sensitivity disappear without provoking exudative epidermitis or epithelitis. By extending the treatment over a longer period than four weeks it will, as a rule, be possible to avoid exudative epidermitis; and by extending it over at still longer period also the epithelitis may be avoided.

These partly theoretical estimates agree very well with our practical experiences. Considerable individual variations must be counted with; but it is my absolute experience that by extending the treatment over a period of six weeks or a little longer we make it far more lenient on the patient, without depriving it of any of its efficacy. That the selectivity thus increases with longer treatment time, can be explained on the theory that the different tissues have different speeds of recovery.

After this we cannot consider the production of epithelitis on the mucosa as the object to be aimed at with the treatment, or as a condition for cure. Several experiences speak against conceiving the epithelitis and the exudative epidermitis as due solely to a directly epithelicidal effect of the radiation; — as a matter between the epithelial cells and the Roentgen-rays alone. To me it seems more likely that the irradiation produces inflammatory changes, specially exudation, in the corium and mucosa. If this exudation becomes so strong that the epithelium is shed, then we get the epithelitis or the exudative epidermitis; if the exudate is resorbed without the epidermis getting completely loosened, then we get the dry epidermitis.

The conception of the vascular and connective-tissue changes as the primary is supported by various observations. There are several pathoanatomical parallels to the roentgen reactions in cases where the epithelial changes are considered as secondary in relation to those in the connective tissue and the vessels. The degree of the reaction to irradiation depends very largely on other factors, which will intensify an inflammation. There may often, just before the reaction culminates, be directly observed on the skin a sub- or intraepidermal exudate, which disappears as soon as the outer layers of the epidermis begin to dry up and get loosened. At the same time, the erythema disappears rather suddenly. Both the epidermitis and the epithelitis can be seen healing up, though the treatment is being continued with the same intensity as before. Finally, there seems to be a distinct parallelism between the degree of the exudative phenomena during the acute reaction, and the degree of the lasting changes, which have their seat in the vessels and connective tissue. The acute epithelial reactions to the irradiation must therefore probably be considered rather as secondary results of the direct effect of the irradiation on the vessels and connective tissue, than as a direct effect of the rays on the epithelium.

SUMMARY

From 1931—1935 the author has treated 151 cases of carcinoma of the pharynx and larynx at the Radiumstation in Copenhagen with protracted fractionated roentgen. In an analysis of these cases he comes to the conclusion that among other things a treatment time lasting three weeks results in an exudative epidermitis which is necessary in order

for the tumor to disappear. Moreover, a treatment time covering four weeks can give results without an exudative skin reaction. Even a longer treatment time can result in a loss of symptoms without an epithelitis because the regeneration curve for skin, mucous membrane, and cancerous tissue is considered to have a different course whereby the selectivity grows greater during longer treatment.

The author wishes to emphasize that he considers the reactions of the epithelium and the epidermitis not as true epidermicidal reactions, but that they are caused by changes in the vessels and in the connective tissue. And finally, in order to avert strong skin and mucous membrane reactions and still obtain satisfactory results one must, in so far as possible, have a sufficiently long treatment time, up to six weeks or more.

ZUSAMMENFASSUNG

Verf. hat in der Zeit von 1931—1935 an der Radiumstation in Kopenhagen 151 Karzinome im Pharynx und Larynx mit protrahierter fraktionierter Radiumbestrahlung behandelt. Bei einer Analyse dieser Fälle kommt er zu Vermutungen, die u. a. darauf hinausgehen, dass eine Behandlungszeit bis zu 3 Wochen eine exsudative Epidermitis erfordert, um Tumorschwund herbeizuführen, während eine Behandlungszeit von 4 Wochen ohne nässende Hautreaktion zum Resultat führen, und eine noch längere Behandlungszeit ohne Hervorrufung von Epithelitis Symptomfreiheit bewirken kann, wie Verf. annimmt dadurch, dass Regenerationskurven für Haut, Schleimhaut und Karzinomgewebe einen verschiedenen Verlauf haben, derart, dass die Selektivität bei längerer Behandlung zunimmt.

Verf. betont, dass er die Epithelitis und Epidermitis nicht als echte epidermizide Reaktionen betrachtet, sondern als Folgen von Veränderungen in Gefässen und Bindegewebe, und er betont ferner, dass starke Haut- und Schleimhautreaktionen vermieden werden sollen und bei genügend langer Behandlungszeit (von 6 Wochen oder mehr) auch vermiedern werden können, ohne dass die Resultate dadurch schlechter werden.

RÉSUMÉ

Au cours des années 1931—1935, l'auteur a traité 151 carcinomes du pharynx et du larynx à l'Institut du Radium de Copenhague, au moyen d'un traitement roentgen fractionné répété. En analysant ces cas, il parvient à poser certaines hypothèses, portant, entre autres, sur ce qu'une durée de traitement allant jusqu'à 3 semaines exige une épidermite exsudante pour amener la disparition de la tumeur, alors qu'une durée de traitement de 4 semaines peut amener un résultat sans réaction cutanée exsudante, et qu'une durée de traitement encore plus longue peut amener l'exemption de symptômes sans que soit provoquée une épithélite, les courbes de régénérescence de la peau, de la muqueuse et du tissu carcinomateux étant présumées suivre des cours différents, la sélectivité augmentant avec la durée du traitement.

L'auteur souligne qu'il considère l'épithélite et l'épidermite non pas comme de vraies réactions épidermicides, mais bien comme dépendant d'altérations du derme et du tissu conjonctif. L'on doit et l'on peut éviter, autant que possible, par une durée de traitement suffisamment longue, c. à. d. de 6 semaines et plus, les fortes réactions de la peau et de la muqueuse, et ce sans que les résultats en soient amoindris.

CANCER OF THE PENIS AND ITS TREATMENT[1]

by

C. J. Hansson

During the 25 year period from 1912 to 1937, 106 patients have come to the Radiumhemmet for cancer of the penis. This group comprises about 0.7 % of the entire cancer material of epithelial origin during this period and about 2.1 % of the cases of cancer in men. In the literature the frequency of this type of cancer in men is given as 1.27 % by ANDREWS, 1 % by PAGET, 2.5 % by VON WINIWATER, 3 % by BILLROTH and 1.3 % by LEIGHTON. During these same years at Radiumhemmet, 1,156 male patients have been treated for squamous cell cancer of the lip, skin or penis. The distribution has been as follows:

Total No.	Lip Ca.	Skin Ca.	Penis Ca.
1156	869 (75.1 %)	181 (15.7 %)	106 (9.2 %)

The literature contains only a few surveys of large series of cancer of the penis. GREENSFELDER reported 202 cases from India where this carcinoma seems to be considerably more common among the colored population than among the whites. Series of 195 and 120 cases are reviewed by BOWING & FRICKE and DEAN respectively. There are also reports on series of from 50 to 100 cases by BARNEY, SCHREINER, DEMARQUAY, LEIGHTON and COLBY.

Cancer of the penis arises as a rule during the so-called cancer age. Thus KAUFMANN and DEAN state that it is commonest between 50 and 60. BARNEY gives 56 years as the average age for its appearance. In LEIGHTON's series most of the patients are in the 6th decade. The following table reveals the age relations in our cases.

Age	Number of cases
20—30	2
30—40	14
40—50	16
50—60	13
60—70	18
over 70	10

[1] Submitted for publication Sept. 28, 1938.

Seventy-eight percent of the patients were over 40 years of age. The highest percentage of them were between 60 and 70 years of age, many were between 30 and 40. The youngest patient was 26 and the oldest 82. COLBY states that one-third of his patients were from 40 to 50 years old.

The literature advances phimosis as the most usual predisposing factor in the origin of cancer of the penis. In BARNEY's series this condition had been present in 85 % of the cases. DEMARQUAY found phimosis in 42 of 59 patients, KAUFMANN in 28 of 33, MARTIN in 36 of 37, LEIGHTON in 13 of 68, COLBY in 50 % and DEAN in 74 % of their cases. The great significance of phimosis and chronic balanitis for the development of cancer of the penis is further emphasized by the fact that this type of tumour is practically unknown among Jews and Mohammedans where circumcision is performed shortly after birth. Most workers in the field stress the importance of circumcision as a prophylactic measure. Our material also supports the significance of phimosis as a predisposing factor, for this condition has been present in most of our cases. Syphilis has also been assigned a predisposing influence. In our series 4 patients had had syphilis and one stated that the cancer arose on the very spot where the chancre had been. Two patients had had ulcus molle but it was impossible to be sure whether the cancer developed on the same site. KRÖNLEIN reported 3 cases where this type of cancer arose after trauma. RODMAN, WHITEFORD, BARNEY and LEIGHTON observed cancers arise in slowly healing wounds following circumcision which had been performed on elderly patients because of phimosis. Our series also contains one instance where cancer developed in an old chronic wound after circumcision. Trauma is mentioned in the history of 5 of the cases in the Radiumhemmet series.

In phimosis a chronic irritation of the praeputium and glans is unavoidable. Stagnant secretion accumulates under the tight foreskin. This secretion breaks down into a number of substances which are chemically irritating to the epithelium. The stagnation also allows the secretion to dry and to form smegma stones which are mechanically irritating.

The cancer begins as a tiny lesion somewhere on the glans or praeputium. At first it is only a small superficial area of infiltration or a wart-like tumour. Gradually ulceration develops in the infiltrated area. If the foreskin cannot be drawn back over the glans the tumour may reach a considerable size before the patient notices it. He usually then discovers a hard area under the praeputium. Sometimes the first symptoms are pain in the glans or a discharge of pus, even occasionally hemorrhage from the praeputical orifice. Discomfort on micturition is rare but does occur, if the cancer is situated at the urethral orifice or if there is edema or an inflammatory infiltration in the praeputium. The cancer is usually inflamed and the regional lymph nodes are enlarged and tender.

Of the 106 cases which have come to the Radiumhemmet, 73 have been accepted for treatment and carefully followed afterwards by means of repeated examination. The other 33 are for the most part cases which came to the Radiumhemmet in such an advanced stage that treatment was hopeless and also patients who were accepted for treatment but did not present themselves. In all of the 73 patients who were treated and controlled the clinical diagnosis was verified by pathological examination. In 72 cases the diagnosis was squamous cell cancer and in one instance adenocarcinoma.

A study of the literature reveals that opinion is rather contradictory as to the best form of treatment of cancer of the penis. Some prefer pure surgical treatment, some radiological with very conservative surgical interference and some a combination of radiological and radical surgical therapy.

Chiefly surgical treatment is utilized by COLBY & SMITH and by LEIGHTON. The former published the results of treatment of 50 cases in the Massachusetts General Hospital. They divided the series into two groups according to the degree of malignancy. Group I was made up of 26 cases of low grade malignancy treated with amputation 6 of which were symptomfree for more than 5 years. Group II consisted of 24 cases with a high degree of malignancy. Two were symptom-free after amputation and excision of the inguinal lymph nodes for more than 5 years. In LEIGHTON's series, four received radiological treatment only. Three of these were dead and one could not be traced. Thirty-four received surgical treatment only. In twenty of these the operation varied from partial to total amputation and bilateral lymph node extirpation. Thirteen lived from 4 to 25 years after the operation. Three of all the patients operated upon died of recurrence. GERÖ, GEZA from Budapest reported 15 cases of cancer of the penis, all treated surgically only and of these 9 were dead. His cure figure was 60 % but the length of the observation period is not stated.

Radiological treatment plus conservative surgical therapy seems to be most used in France, Belgium and England. No large series of cases has been published in these countries and the period of control is too short to provide any definite information as to the value of the method. BARRES & HEYMAN in Tonkin treated 13 patients with local implantation or surface application of radium only. They considered that they had obtained good results but the length of the cure is not stated. FERRARI & VIALLET in Algiers treated 2 cases with surface application of radium over the tumor and obtained 4 and 5 year cures. SCHLOSS & URBACH in Vienna reported 10 cases treated with surface application of radium. Four of these were also given teleradium or röntgen treatments over the inguinal regions. SCHLOSS & URBACH consider that the results were

primarily good but the observation time is not longer than 1 year. DUGRAIS in Paris treated 17 cases with local surface application or implantation of radium and recommends surgical exposure of the tumour if it is difficult to get at radiologically. The metatases were removed surgically following röntgen treatment. The cure figure was 25 % but the length of the observation period is not mentioned. GROSMAN used the same method of treatment for his cases. HUTCHISON in Manchester felt that he had obtained good results with radiotherapy for cancer of the penis. He surrounded the organ with a cylinder in which the radium needles were applied in 4 rows. He found that the radiation became more homogeneous when administered in this way. He treated 10 cases and obtained cures in 5. The length of the follow-up period is not stated. In 4 cases an amputation had to be done afterwards. He considered that even in the presence of metastases, radiological treatment should be tried first and that radical surgical therapy should be employed only as a last refuge. MURDOCH & SIMON in Brussels used local implantation of radium needles irrespective of the size of the tumour. The metastases were removed surgically after radiation. In 16 cases without metastases primary healing was obtained in 9 and of 3 patients with metastases 2 died of cancer. One was symptom-free after 4 years.

In recent years most of the larger statistical studies of the results of treatment of cancer of the penis come from the United States. Radiological treatment plus radical surgery such as amputation and groin dissection have been employed in all of these instances.

SCHREINER of Buffalo treated 60 cases in this way. He divided the material into 2 groups. In Group I he placed cases without metastases and in Group II those with metastases. In the first group there were 2 patients who were treated with local röntgen radiation only. They lived 8, 5 and 10 years after treatment. In the other cases radical surgical therapy plus postoperative radiological treatment had been utilized. Of 23 patients 22 lived from 2 months to 27 years after treatment had been utilized. In Group II were 37 cases of which 2 were symptom-free 5 to 13.5 years after treatment. OVERHOF in Frankfurt am Main divided his material of 22 cases into 4 groups according to the treatment applied. Group I consisted of 4 patients who were first operated upon and then given radiotherapy. A five year cure was attained in one of these. In Group II he placed 4 patients who were operated upon and did not receive radiotherapy until signs of recurrence developed. The longest cure was 2 years. Group III contained 8 patients who received only röntgen treatment. One was symptom-free after 4 years and one after 6. Group IV was made up of patients who received preoperative radiation then operation and more radiation again within 3 months. Of these 6 cases 2 were symptom-free

after 6 years. PFAHLER & WIDMANN, Philadelphia, recommended preoperative treatment with high voltage röntgen apparatus and subsequent amputation with electrocoagulation. Their 11 cases so dealt with showed 90% cures. The length of the observation period is not stated. BOWING & FRICKE reported the results of treatment of cancer of the penis at the Mayo Clinic. The material which consisted of 195 cases was divided into 4 groups. In Group I were 41 cases described as having small tumours without metastases. Fourteen of these were 5—10 year cures and 5 were 10—15 year cures. One patient had been symptom-free for over 20 years. Group II contained 36 cases with small tumours plus metastases. Five patients were symptom-free from 5 to 10 years, 4 from 10—15 years and one over 15 years. Group III consisted of 32 patients with large tumours and no metastases. Eight were 5 to 10 year cures. Group IV contained 86 cases with large tumours plus metastases. Eleven were symptom-free from 5 to 10 years. The method of treatment for the different groups is not stated. In the entire series 62 received surgical treatment only, 86 combined surgical and radiological and 47 were not treated at all. Seventy-seven of the entire series died of cancer. HORN & REED of Ann Arbor treated 27 patients with the combined method. Of these 10 lived 4 to 10 years after treatment, 13 died of cancer and 4 could not be traced. DEAN JR. of the Memorial Hospital has had the most experience with this type of cancer and its treatment. In a series of papers in 1926, 1929 and 1935 he has gone into this problem in great detail. He differs from most of the other American workers in that he does not employ quite as radical surgical therapy. His last report in 1935 deals with 120 patients which he divides into 3 groups. In Group I are the tumours less than 2 cm. in diameter and not accompanied by metastases. In Group II he places tumours larger than 2 cm. in diameter and without metastases. Group III contains all cases with metastases. The treatment in Group I consisted of surface application of radium or implantation of radium needles. Nine of the 12 patients lived and 5 of them were 5 year cures. The cases which belonged to Group II were first treated with surface application or implantation of radium. Then amputation was done at least $1^1/_2$ cm. from the tumour. Of the 51 patients in this group 33 were alive and 18 of them were 5 year cures. The third group was treated primarily as Group II and only as a last resort were the lymph nodes dissected out. There were 40 patients in this group but only 2 were alive and neither was a 5 year cure. DEAN considers that lymph node extirpation should be delayed until the effect of the amputation can be estimated because in his opinion a large proportion of suspected metastases are only lymph nodes which are enlarged due to inflammatory lesions. He also stresses the importance of removing the source of infection in time so that the protective function of the lymph nodes

is not unnecessarily depreciated by protracted infection. He considers that radiological treatment of metastases is without promise partly because of their radioresistance and because the lymph nodes are often infected and partly because the skin in the inguinal regions cannot stand such heavy doses. CAMPBELL & GRAVES have expressed a similar opinion on the treatment of cancer of the penis.

In our material it is predominantly radical surgical treatment which has been employed while the radiological therapy has been administered partly preoperatively and partly postoperatively in the form of radiation of the regional lymph nodes. In only a few instances has local radiological therapy been resorted to.

For the purpose of discussing the treatment, the material has been divided into 3 groups. These are dependent on the clinical status of the lymph node areas at the beginning of treatment. The classification with reference to the lymph node status has been described in a number of papers from the Radiumhemmet by BERVEN where it was first used in connection with malignant tumours of the oral cavity.

Stage I. Without clinically demonstrable lymph node metastases.

Stage II. With clinically positive lymph node metastases where the cancer is clinically limited to the nodes. Operable.

Stage III. With lymph node metastases where the cancer has begun to break through the lymph node capsules. Inoperable.

As BERVEN has remarked, the borderline between these stages is not sharp and the classification requires great clinical experience. The following figures show the distribution of the present material in the different stages.

Stage I	45 = 62 %
Stage II	16 = 22 %
Stage III	12 = 16 %

In Stage I were 45 cases and 15 of these were suspected of having metastases at the time of the clinical examination. In all of these patients the lymph nodes were removed from both groins but the microscopic examination showed only inflammatory lesions. This series contains no example of »clinically latent» or clinically manifest metastases having been overlooked, that is, no case was diagnosed as Stage I which should have been counted as Stage II. It is however a well known fact that in spite of the absence of clinical signs of metastasis a cancer can have spread to the lymph nodes. Thus COLBY mentions that he had 4 cases where no enlarged lymph nodes could be palpated but where the microscopic examination revealed cancer growing in them. In the present material on the contrary it seems to be rather usual to mistake inflamma-

tor alterations in lymph nodes for metastases. This has been pointed out by BERVEN in connection with cancer of the mouth and by DEAN in regard to cancer of the penis.

There were 16 cases in Stage II and dissection of the lymph node area was done in 11 of these. In all 11 the microscopic examination showed cancer in the nodes. In the other 5 cases the subsequent course revealed that the clinical diagnosis had been correct. The 12 cases which were in Stage III were all far advanced. In some of them a hard cord could be palpated from the cancer up to the inguinal lymph nodes which were in all cases markedly enlarged, hard and immovable. The skin over the metastases was infiltrated with cancer in some cases.

The entire material consists of 73 treated cases but 27 of these were admitted since 1932 and as the period of observation is thus under 5 years they have not been included in the discussion of the results of treatment. Forty-six have been followed for at least 5 years and make up the cancer of the penis material from 1912 to 1932.

The following table shows the distribution of these cases according to stages and the number symptom-free after 5, 8 and 10 years.

	1912—1932 5 year cures		1912—1929 8 year cures		1912—1927 10 year cures	
	No.	Symptom-free	No.	Symptom-free	No.	Symptom-free
Stage I	27	23 (85 %)	15	9	10	4
Stage II	12	7 (58 %)	5	2	4	1
Stage III	7	0	4	0	4	0
Total	46	30 (65 %)	24	11 (46 %)	18	5 (28 %)

Many of the patients from the periods 1912—1927 and 1912—1929 died of intercurrent diseases but none of cancer. This explains why the figures for the 8 and 10 year cures are lower than for the 5 year ones.

Of the 27 patients who were in Stage I, 23 are symptom-free after 5 years and 4 are dead. Two of the latter died in direct connection with operation and 2 from intercurrent disease but free from cancer. Of the 12 cases in Stage II, 7 are symptom-free and 5 have died of cancer. Of the latter, 2 died within one year with local recurrence; one case was treated in 1914 and the other in 1916, the therapy consisting solely of surface application of radium. The remaining three instances died in the second year after treatment because of ulcerating metastatic lesions in the inguinal lymph nodes.

All the 7 cases diagnosed as in Stage III have died of cancer. Six of these died within one year and one within three years after treatment.

In order to obtain a general survey of the method of treatment and the results, each stage has been analysed by itself. The following

tabulation is mentioned to show the types of therapy which have been used for patients in Stage I.

Treatment.

Radiological only		Excision + postoperative röntgen treatment of lymph node areas		Amputation + radiological treatment of lymph node areas		Amputation + dissection of lymph node areas + radiological treatment of these regions	
No.	5 year cures	No.	5 year cures.	No.	5 year cures	No.	5 year cures
3	2	1	1	13	10	10	10

Three patients received radiological treatment only, one in 1912 (the first cases in the series) and the others in 1920 and 1921 respectively. The first two are both symptom-free after 5 years. The third died in 1923 of pyelonephritis but free from cancer. The first two were treated by surface application of radium locally and in the groins and the third received röntgen treatment locally from two portals (4 × 1/3 HED). The follwoing is a brief summary of the first case of cancer of the penis which was treated at the Radiumhemmet.

No. 137/1912. E. G. 61 years of age. Syphilis when young. Cured after antiluetic treatment. For 6 months before admission to Radiumhemmet had noticed that there was an ulcerated area of infiltration on the right side of the glans. On examination a disc-shaped area of resistance was palpable on the right side of the glans. In the center of this area was an ulcer 4 × 11 mm. with ragged edges and an easily bleeding base. The histological examination of a biopsy revealed the presence of a cancroid (Prof. BERGSTRAND). The tumour was treated by surface application of radium in 10 seances of altogether 34 hours. The total dosage was 1,360 mgr. hrs. The lymph nodes in both inguinal regions were also treated with surface application of radium in 3 seances and a total dose of 1,600 mgr. hrs. to each area. The tumour healed and the patient lived symptom-free for 8 years. He then died of arteriosclerosis.

The other 2 cases which received only radiological treatment had also small superficial tumours and although this method of treatment cannot be evaluated from 3 cases, it was nevertheless satisfactory in each instance. In spite of the encouraging result with radiological treatment alone for small superficial tumours, this method could not be tested out again until 1933 because of the rarity of such early cases. Since 1933, 3 more patients have received radiological treatment only but in these cases radium needles have been implanted and then the lymph node areas have been given teleradium treatment. Two of these cases are from 1933 and 1934 and both are symptom-free in December 1937, the third year after treatment. A review of the material also shows that in 13 instances the penis has been amputated without removal of the inguinal lymph nodes. Of these patients 1 received preoperative röntgen and postoperative teleradium treatment over the lymph node areas, 2 preoperative

röntgen treatment only and 7 postoperative treatment only. The röntgen treatment was fractional with 1/4 to 1/3 HED daily and a 1—2 HED total dose. The THORÆUS filter or 1/2 mm. Cu.—1 Al. was used. The teleradium was also fractioned and the total dose varied from 22 to 40 gr. hrs. The distance was 6 cm. and the treatment was administered over about 8 days. Of the 13 patients 10 are alive symptom-free for 5 years or more, 2 died in connection with operation and 1 of intercurrent disease free from cancer.

Because metastasis was clinically suspected the lymph node areas were also dissected out in 10 cases where amputation was done. In none of these lymph nodes was cancer microscopically demonstrable. Five of these 10 patients received only postoperative röntgen treatment over the amputation stump with the same doses as were mentioned above. In addition to preoperative röntgen treatment 2 were given teleradium treatment over the tumour in doses of 15 and 26 gr. hrs. respectively. Of the remaining patients 1 received preoperative röntgenological and postoperative teleradium treatment, 1 had both röntgenological and teleradium treatment postoperatively and 1 had teleradium postoperatively. All of these patients are symptom-free 5 years or more.

Only 1 patient was treated with excision of the tumour and subsequent röntgenological treatment of the lymph node areas. He was also symptom-free after 5 years.

There were 12 cases in Stage II. In 7 of these the diagnosis of metastasis was microscopically verified. The subsequent course in the remaining 5 revealed that the clinical diagnosis was correct. The following is a summary of the method of treatment and results in this group.

Treated radiologically only		Excision, dissection of lymph node areas[1] and radiological treatment		Amputation and radiological treatment of lymph node areas		Amputation + dissection of lymph node areas + radiological treatment	
No.	5 year cures	No.	5 year cures	No.	5 year cures	No.	5 year cures
2	0	2	1	2	0	6	6

The 2 patients who received only radiological treatment in the beginning died of cancer 1 year afterwards. In both instances the cancer was treated with surface application of radium. The one patient received röntgenological, the other teleradium treatment over the inguinal areas. In the one case surgical therapy was also resorted to but not until 4 months after radiological. The following is a brief summary of the case history.

181/1914. F. S. 67 years of age. For 6 months before admission to Radiumhemmet the patient had noticed a small hard area near the urethral orifice. The infiltration had

[1] lymph node areas dissected out in only one case.

spread over the glans and an ulcer had developed near the sulcus glandis. Clinically there was a superficial ulcer with a disc-like area of infiltration up over right side of the glans. In the right inguinal region a spindle-shaped movable pea-sized lymph node could be palpated. He was treated in 2 seances with superficial application of radium, locally and in the right groin. Four months later there was a recurrence, the penis was amputated and the lymph nodes dissected out. Microscopic examination showed proliferating cancer cells in the tumour area and in the nodes. The patient died of cancer one-half year later.

Excision of the tumour with postoperative radiological treatment was done in 2 cases. One of these patients who received postoperative röntgen treatment died within one year, the other is alive symptom-free $6^1/_2$ years after treatment. His case history is briefly as follows.

5978/1930 D. L. 54 years of age. The patient had had a tumour on the corona glandis for some time. The tumour was extirpated and after the operation the patient was sent to the Radiumhemmet for radiological treatment. Clinically there was no evidence of recurrence in the operation scar. The left inguinal region contained a firm bean-sized lymph node. Three 50 mgr. radium tubes were placed over the scar for 8 hours. He was given 15 gr. hrs. of teleradium over each lymph node region. The lymph nodes were dissected out on the left side $1^1/_2$ years later when the one node seemed to increase in size. Microscopic examination by Dr. REUTERWALL showed a cornifying squamous cell carcinoma in this node. Postoperative teleradium treatment was administered over the left inguinal region. The treatment was distributed over 3 fields and a total dose of 72 gr. hrs.

Two cases were treated by amputation and radiation of the metastases in the groin and both died of cancer within 1 year.

Six patients were treated by amputation and lymph node dissection and all are alive and symptom-free 5 years or more. The metastases were unilateral in 5 cases and bilateral in one. The diagnosis of metastasis was microscopically verified in all cases by Dr. REUTERWALL. The following is a brief summary of these case histories.

857/24. V. B. 33 years of age. The patient had had an infiltrated ulcer in the sulcus coronarius for 8 months before the penis was amputated. Six months after the first operation a node was removed from the left groin and micoscopic examination revealed the presence of a cancer metastasis. Postoperative radiological treatment was given over both inguinal areas. This consisted of teleradium in a dose of 33 gram hours and then röntgen treatment in 2 seances 2 months later. There was an interval of $1^1/_2$ months between treatments. At the first sitting he received altogether 1 HED and at the second $^3/_4$ HED. In both instances the filter consisted of $^1/_2$ mm. Cu.—1 mm. Al. The patient has been symptom-free 9 years since the last treatment. The last examination was $^1/_2$ 1938.

1857/1929. F. G. 49 years of age. The patient had noticed a pea-sized tumour on the under side of the penis close to the frenulum beneath the foreskin. The tumour grew rather rapidly and was the size of a hazel nut 2 months later at the operation when amputation and dissection of the lymph nodes in both inguinal regions was done. Microscopic examination revealed squamous cell cancer with metastasis in one lymph node. He received postoperative teleradium treatment in both inguinal areas. On the left side the dose was 27 gr. hrs. at 5 cm. distance and 2.7 gr. hrs. at 3 cm. over 2 fields. On the right side he received 30 gr. hrs. Three months later a new teleradium series of 18 gr. hrs. was

given over each groin. Four months later a pea-sized metastasis was palpated in the right groin and four 10 mgr. radium needles were implanted. He has now been symptom-free over 7 years since the last treatment. The last control examination was made 12/2 1938.

2425/1931. A. L. S. 35 years of age. The patient had had phimosis discomfort since childhood. Six months before admission he had noticed a tumour in the right groin and for 3 months he had been troubled with pain in the glans penis and a purulent discharge from the praeputical orifice. The tumour in the groin was extirpated and microscopic examination showed it to be a lymph node metastasis of a squamous cell cancer. Renewed examination of the penis revealed a tumour infiltration in the praeputium. The penis was then amputated and the lymph nodes dissected out of both inguinal areas. He was given postoperative teleradium treatment in 2 seances. At the first he received 30 gr. hrs. from 6 cm. distance over 2 fields in each groin and at the second 4 months later 12 gr. hrs. in each groin. He has been symptom-free for more than 6 years since the last treatment. The last control examination was made 7/12 1937.

3372/1931. K. S. 63 years of age. At 30 years of age the patient was operated upon for phimosis and again 32 years later. The wound after the latter operation did not heal. Six months later he noticed on the glans 2 nodules which gradually grew to the size of hazel nuts. These tumours were extirpated and the histological examination revealed a squamous cell papilloma of precancerous type. He was sent to the Radiumhemmet for radiological treatment. Clinically the praeputium had been extirpated and the wound had not yet healed. On the inferior surface of the glans there was a palpable area of infiltration and a suspected metastasis in the right groin.

He received röntgen treatment in both inguinal areas in 2 seances at a 2 months interval. At each seance the total dose was 1 HED with a tin filter. During 1932 a number of precancerous plaques on the glans were treated by surface application of radium. In October of the same year the microscopic examination revealed certain squamous cell carcinoma. The suspected metastasis in the right groin had increased in size. The penis was then amputated and the lymph nodes dissected out of the right inguinal region. Microscopical examination verified the clinical diagnosis of metastasis. The patient has been symptom-free 5 years since the last treatment. The last control examination was 28/10 1937.

7443/1931. H. M. 77 years of age. Eight or nine months before coming to Radiumhemmet the patient had noticed a small hard area on the right side of the glans. This area had increased in size and at the time of the first examination there was a plum-sized broken-down tumour involving the entire glans. A firm cord of metastases extended from the tumour up to the walnut-sized lymph nodes in the right groin. There was a pea-sized metastasis in the left groin. The penis was immediately amputated and the lymph nodes dissected out of both inguinal regions. Microscopic examination show squamous cell cancer with metastases in the lymph nodes in both groins. One and one-half months after the operation he was given teleradium treatment over 2 fields in each groin. The total dose on each side was 30 gr. hrs. He has been symptom-free 6 years since the last treatment.

3766/32. R. G. 40 years of age. The patient had had recurrent ulcers on the foreskin since 22 years of age. One year before coming to Radiumhemmet he had noticed a wall-like hard area at the muco-cutaneous junction between the praeputium and glans. This firm area had slowly increased in size and had occasionally bled shortly before admission. Clinically the praeputium was bluish-red, edematous and swollen. At the mucocutaneous junction was a broken-down slightly bleeding area of infiltration. The left inguinal region contained a hard movable metastasis 1 cm. in diameter. The penis was immediately amputated and the lymph nodes were dissected out of the left

groin. Microscopic examination revealed squamous cell cancer with metastases throughout the lymph nodes. He was given 29 gr. hrs. postoperative teleradium treatment over 2 fields in the left groin and $1^1/_2$ HED röntgen treatment in one dose through a tin filter over the right groin. He has been symptom-free for 5 years since the last treatment. The last examination was made 8/12 1937.

The penis cancers with large non-movable, inoperable metastases were diagnosed as Stage III. The treatment in all 7 cases has been only palliative. The following table shows the technique used.

Radiological treatment only		Electrocoagulation + teleradium locally		Excision + dissection of lymph node areas + postoperative radiological treatment		Amputation + dissection of lymph node areas + postoperative teleradium treatment	
No.	5 year cures	No.	5 year cures	No.	5 year cures	No.	5 year cures
1	0	1	0	2	0	3	0

As the table shows, all 7 patients are dead. Six died within 1 year and one 3 years after the treatment.

Discussion of the therapy.

Radiotherapy alone for cancer of the penis has on the whole given unsatisfactory results at the Radiumhemmet as at other tumour clinics. It would seem as if there are several unfavourable contributory factors. (1) Cancer of the penis is as a rule a highly differentiated hornifying squamous cell carcinoma of relatively low radiosensibility. (2) Cancer of the penis is usually the seat of considerable infection because of the closed-in position due to phimosis and because of the presence of chronic balanitis. It is generally recognized that infection has a very unfavourable influence on the radiotherapy of cancer. (3) The normal tissues of the penis such as the skin on the praeputium and glans undergo radionecrosis much more easily than for instance the skin of the face and neck. The presence of moisture and warmth give rise to maceration which together with the chronic infection contribute to the development of necrosis.

In the above three respects cancer of the penis corresponds rather well to cancer of the vulva which at the Radiumhemmet is nowadays treated by electrocoagulation according to the technique of BERVEN. This method has given much better results than that obtained before 1920 when vulva cancer was treated by local application of radium.

In our opinion the prospect of cure is best with a combination of radiological and surgical treatment. At present we follow the following principles:

Stage I (Cases without clinically demonstrable lymph node metastases).

a) Small superficial papillomatous and relatively benign carcinomas are treated with radium locally, preferably by implantation, in relatively cautious doses. The prospect of cure is good but there is always a certain risk of later necrosis. We therefore prefer electrocoagulation with a flat or spherical electrode. If satisfactory healing does not commence or if recurrence is suspected, immediate amputation is advised. In the case of patients around 70 years of age it is certainly wisest to do an amputation in the beginning even for these small and relatively benign tumours.

The lymph nodes in the inguinal regions are treated prophylactically with röntgen or preferably with teleradium. No surgical dissection is done except later in the course if there arise clinical signs of lymph node metastases.

b) Larger ulcerated tumours infiltrating under the skin should be dealt with by immediate amputation of the penis. Very little is gained by attempting to diminish the inflammation with local disinfectants or small röntgen doses. Instead the safest way to prevent metastasis is a radical removal of the source of infection. The lymph nodes are treated prophylactically as in the previous group. A careful follow-up is of still more importance here because of the greater danger of lymph node metastasis in the later course. If such metastases are discovered early they can frequently be successfully treated according to the principles used for Stage II.

Stage II (Cases with clinically positive operable lymph node metastases).

As in the previous group, amputation should be performed without any delay. However we agree with DEAN that the lymph nodes should not be dissected out at this time. In the first place it often happens as DEAN points out that the enlarged nodes are the seat of inflammation and not metastasis. They may rapidly diminish after the amputation and then a disection becomes unnecessary. In the second place we feel that the prospect of permanent cure is considerably greater if a rather large dose of röntgen or teleradium is the primary treatment given the lymph node areas. The condition of the nodes must then be followed carefully. If clinical examination still seems to suggest the presence of metastasis the nodes are dissected out surgically after one or two months. Otherwise they are subjected to repeated examination. This method of procedure in regard to lymph node metastases has given particularly good results in the treatment of hornifying squamous cell carcinoma in other regions such as the oral cavity and vulva (BERVEN).

Stage III. (Cases with inoperable lymph node metastases.)

In the cases where the amputation incision can be carried through noncancerous tissues, the operation may provide a good palliative result by partially reducing the infection in the lymph nodes or by doing away with pain and difficulty with micturition. On the other hand if there are palpable strands of cancer growing continuously from the primary tumour up to the inguinal regions, then amputation has no palliative value.

The lymph node metastases can be treated by fractional external radiation with small daily doses which alleviate the pain and help to clean up the foul-smelling necrotic ulcers.

SUMMARY

The author gives an account of the 106 cancers of the penis treated at the Radiumhemmet during the 25 year period 1912—1937. The material is divided into 3 groups according to the findings in the lymphnode regions at the beginning of treatment. *Stage I:* Without clinically demonstrable lymphnode metastases. *Stage II:* With clinically positive lymphnode metastases, operable. *Stage III:* With metastases beginning to break through the lymphnode capsule, inoperable. 62 % of the cases were in Stage I, 22 % in Stage II and 16 % in Stage III. The methods of treatment and the results are analysed in those cases which had been followed at least five years. In Stage I there are 85 % 5-year-cures and in Stage II 58 %. All the cases belonging to Stage III died of cancer within five years. Only in a few instances was the treatment radiological only. Most of the cases received a combined radiosurgical treatment. The author believes that this therapy provides the greatest prospect of success.

ZUSAMMENFASSUNG

Verf. berichtet über das Cancer-penis-Material des Radiumhemmets von den Jahren 1912—1937. Die Anzahl der Fälle betrug 106. Das Material wurde in drei Gruppen eingeteilt. Diese Einteilung war durch den klinischen Status bedingt, in dem sich die Drüsenregionen zu Beginn der Behandlung befunden hatten. *Stadium I:* Ohne klinisch nachweisbare Drüsenmetastasen. *Stadium II:* Mit klinisch sicheren Drüsenmetastasen; operable Fälle. *Stadium III:* Mit Drüsenmetastasen, die begonnen hatten, die Kapselwand der Drüsen zu durchbrechen; inoperable Fälle. 62 % der Fälle gehörten zum Stadium I, 22 % zum Stadium II und 16 % zum Stadium III. Behandlungsweise und Behandlungsresultat waren an denjenigen Fällen untersucht worden, die wenigstens 5 Jahre lang in Beobachtung gewesen waren. 5jährige Heilung wurde im Stadium I bei 85 % und im Stadium II bei 58 % erreicht. Sämtliche Fälle der Gruppe III starben vor Ausgang der 5-Jahres-Periode an Kanzer. — Die Behandlung war nur in einer kleinen Zahl von Fällen ausschliesslich radiologisch. Im Hauptteil des Materials wurde eine kombinierte radio-chirurgische Therapie angewendet. Verf. gibt der Ansicht Ausdruck, dass bei dieser Therapie die grössten Aussichten auf gute Resultate bestehen.

RÉSUMÉ

L'auteur rend compte des 106 cas de cancer du pénis traités à Radiumhemmet pendant les 25 années de la période 1912—1937. Cette matière est divisée en trois grou[illegible]es,

suivant l'état clinique des régions des glandes au début du traitement. *I:er stade*: Sans métastases des glandes cliniquement démontrables. *II:e stade*: Avec métastases des glandes cliniquement positives, opérables. *III:e stade*: Avec métastases des glandes commençant à percer à travers la paroi capsulaire des glandes, inopérables. 62 % des cas appartenaient au I:er stade, 22 % au II:e stade et 16 % au III:e stade. Les modes et les résultats des traitements sont analysés dans les cas observés pendant un minimum de 5 ans. Le I:er stade présente 85 % et le II:e stade 58 % de guérisons au bout de 5 ans de cure. Tous les cas appartenant au III:e stade décédèrent du cancer avant l'expiration des 5 ans. — Le traitement fut exclusivement radiologique dans quelques rares cas seulement. Dans la plupart des cas, on appliqua une thérapie radio-chirurgique combinée. L'auteur exprime l'avis que cette dernière thérapie offre les plus grandes chances de réussite.

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PEPTIC ULCER OF THE ESOPHAGUS[1]

by

Flemming Nørgaard

Peptic ulcer of the esophagus is in itself an uncommon disease, and still rarer are the cases in which it has been diagnosed primarily at roentgen examination, though that is mostly the special examination to which the patient is first subjected, and though the films may reveal marked, characteristic changes. A case observed in the roentgen clinic of the State Hospital suggests a consideration of the causes of this seeming inconsistency.

The patient, a little girl, was admitted for the first time to the children's ward of the State Hospital in 1931, when she was 3 years old, because she was subject to violent attacks of vomiting with resulting inanition. Physical examination showed her to be suffering from infantile scurvy and severe anemia. Roentgen examination revealed a considerable narrowing of the distal one-third of the esophagus, where only a string-like passage was left; and above this a dilatation. (Fig. 1.) There was no question of erosion stricture; it was undoubtedly a spasm; and this, as well as the vomiting, was judged to be due partly to psychic causes. Under lengthy treatment with sedatives her condition also improved somewhat; but as soon as she had been taken back home it became just as bad as before, with daily attacks of vomiting, as a rule in the middle of meals; and on one occasion, at least, blood was observed in the vomit. She could swallow only liquid and very soft food.

In 1935, when she was 7 years old, she entered the hospital a second time. She was now very emaciated, anemic, and perhaps a little backward mentally. During her stay she had several attacks of vomiting almost daily, amounting to as much as 3—4 litres a day; several times copious hematemesis and melena, and almost constantly occult hemorrhage. Her condition was at times extremely serious.

At admission she complained of pain back of the sternum and between the shoulder-blades, specially towards the right. This pain at times became so intense, and caused her to refuse food so energetically, that it became necessary to give her morphines. Atropine preparations had some effect against the vomitings. Once, the anemia made it necessary to resort to blood transfusion.

Repeated roentgen examinations of the esophagus continued to show spasm and dilatation; but of varying appearance, proving that the condition was not of cicatricial origin.

[1] A paper read at the meeting of the Northern Association of Medical Radiology in Copenhagen, June 29th, 1938; submitted for publication, Aug. 22nd, 1938.

At an examination in 1936, during a period when swallowing was causing the patient great pain, and shortly after she had for several days had copious hematemeses, there was noted, however, besides the spasm and dilatation, a contrast spot, the size of a small pea, projecting slightly to the side of the lumen, about at the level of the tenth thoracic vertebra. It was surrounded by a rarefied annular zone, and resembled exactly the ulcus niches one finds in other localities (Fig. 2). Renewed scrutiny of the films from an examination of the patient made in 1935 showed that it undoubtedly was present already then (Fig. 3), but not so characteristically as to suggest the idea of an ulcus.

Direct esophagoscopy was now carried out. It showed extensive thickening of the anterior wall 8 cm. from the cardia, but details could not be observed owing to bleeding. Sodium bicarbonate was found to have a good effect against the pain, and after the introduction of a duodenal sound, which was left in position for long periods at a time, the patient's condition improved considerably. The symptoms still recurred from time to time, but never as violent as before.

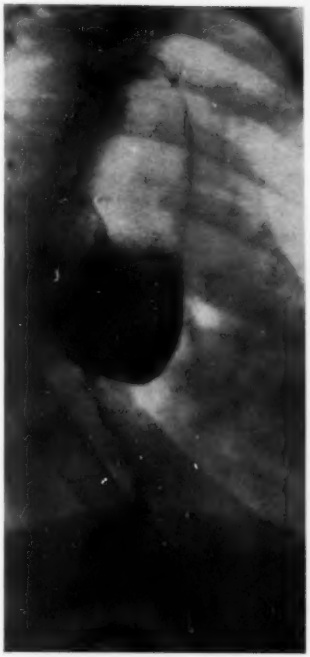

Fig. 1.

As already shown by QUINCKE in 1879, the pathoanatomical changes in cases of peptic esophageal ulcer are of the same character as in ulcers of the stomach and duodenum; that is to say, a fairly circumscribed loss of substance in the mucosa, extending more or less deeply into the submucosa, sometimes also into the underlying musculature; and as a rule accompanied by secondary inflammatory manifestations in the adjacent areas. These ulcers can become as large as a bean, in exceptional cases larger; and are most often situated in the posterior wall, in the lower half of the esophagus. The disease is found in subjects of all ages, from new-born infants and small children (BURGHARD, HINDSE-NIELSEN; HAROEN and GERLINGS) to the very old (HURST); and like gastric and duodenal ulcers somewhat oftener in males than in females; the ratio in this respect being about 3 to 1. Of the incidence it is difficult to say anything precise. The statements vary, and will always be uncertain even if based on post-mortem material; partly because it depends on how much attention the investigator gives to this particular region, partly because a number of lesions heal.

In 1929, STEWART and HARTFALL reported 1 case, and stated that it was the only one found among a material of 10,000 necropsies in the

Fig. 2.

Fig. 3.

course of eighteen years. GRUBER found, in over 2,400 necropsies, 6 cases of esophageal ulcer or cicatrices after such. In the same material, the number of ulcers, or cicatrices after ulcers, of the stomach and duodenum was 164. Larger series of cases, all diagnosed by esophagoscopy, have been published from American oto-laryngeal clinics. JACKSON, for instance, among 4,000 patients with affections of the esophagus, observed 88 cases, 21 of which were active ulcers. Still, not even this furnishes a sufficient basis for estimating the frequency of the disease. So far, the best idea of its incidence is gained from GRUBER's material, which shows 1 case of esophageal to, roundly, every 30 of gastric and duodenal ulcer.

The etiology of esophageal ulcers, like that of ulcers in the stomach and duodenum, is still uncertain; but the condition is believed to be due to the action of gastric juice on a feebly resistant mucosa. As in respect to

gastric and duodenal ulcers. (REHFUSS, 1927), a distinction must perhaps be made between the causes that produce the acute ulcus and those which cause the latter to pass into the chronic stage. The primary acute ulcer may no doubt be due to a great variety of causes. JACKSON emphasises the rôle played by focal infection in the mouth and the naso-pharyngeal cavity, specially from the tonsils; which in his 88 cases was an almost constant factor. Others, like TILESTON, believe that excessive use of alcoholic beverages is a specially exciting factor; but this still leaves part of the cases unexplained, seeing that esophageal ulcer occurs also in newborn and quite small children. That the action of acid is an important element in determining the passage from the acute to the chronic stage seems highly probable, not only from clinical observation, but also from the studies of FRIEDENWALD, FELDMAN and ZINN, who found that chronic ulcer of the esophagus could be produced experimentally in animals by repeated applications of acid to deep-going lesions in the walls of that organ.

In many of the patients an effect of the gastric juice is clearly seen in regurgitation or vomiting. The not infrequent association of esophageal ulceration with gastric or duodenal ulcer, for instance, offers ample opportunity for this action of the gastric juice, owing to the hypersecretion, hyperacidity and ejection of food from the stomach which invariably follow the latter lesions. But it should also be noted that in not a few cases of peptic esophageal ulcer islands of heterotopous gastric glands, which undoubtedly possess the quality of acid secretion, have been demonstrated in the esophagus. Such glands were present in the case reported by STEWART and HARTFALL, and in no less than 7 of JACKSON's twenty-one cases of active ulcer.

In pronounced cases, the symptoms are pain behind the sternum or in the back, initiated by swallowing, but in many cases not coming on until some time — from 30 minutes to 1 hour — after meals, or perhaps only after the principal meal; hematemesis, melena, dysphagia and vomiting. Very often, however, — and this was the case in half of JACKSON's patients, for instance, — the symptoms will not at all be suggestive of an affection in the esophagus. They may be entirely gastric, or sometimes there may be only a slight hematemesis, without other symptoms. Obstruction seems not to occur in the early stages.

Roentgen examination is sometimes negative as regards abnormalities (JACKSON). The most common observation is spasm (BARCLAY, CABOT, CONOLLY, HELLMAN, MAINZER, PESEK, SCHWARTZ). Very rarely spasm and a contrast-filled ulcus niche have been demonstrated (AURELIUS, BRUNETTI, FLEISCHNER, HURST, PESEK, SCHWARTZ). Sometimes also broad folds of mucosa are seen, as indication of esophagitis (SCHATZKI). Where spasm and niche are demonstrated, the finding is characteristic

and proves the diagnosis absolutely to any observer who bears the existence of the affection in mind. The cases in which spasm alone is demonstrated are the most frequent. The spasm may be double, above and below the ulcus; or single, in the latter case often located above the ulcus. Specially these cases and the cases with negative roentgen finding in spite of marked symptoms of esophageal affection should be the object of attention on the part of the roentgenologist. In this connexion there is reason to point out that in the cases where the absolute pathognomonic signs, spasm and niche, have been demonstrated, this demonstration has almost invariably, and, for instance, also in the writer's own case, been made only as the result of several times repeated examination.

I would also point out that the demonstration of the niche, in our case, was made at one of the numerous roentgen examinations carried out during a period when the patient's symptoms, in the form of intensely painful deglutition and several severe hematemeses, were particularly pronounced. This is a counterpart to one of the cases reported by HURST, in which thrice repeated ordinary examination of the esophagus revealed nothing abnormal, whereupon a fourth examination after the patient had been given a solid meal mixed with barium showed the cardia open, and immediately above it a large contrast-filled ulcus crater, and proximal to the latter a spasm with stasis above it. There is also a certain analogy between this and the demonstration, by BARCLAY, that the spasms are provoked by pain. He had the patient swallow hard bread mixed with contrast substance; and when it passed the ulcer a total obstruction of the esophagus occurred, owing to a spasm which persisted for from 5 to 10 minutes.

In respect to other affections of the esophagus it has specially been discussed whether the examination ought to be a study of its moulding, with employment of only a slight quantity of contrast substance, or whether it should be attempted to fill the tube as completely as practicable in order to obtain a positive roentgen finding in as many cases as possible. So far as peptic ulcer is concerned this question seems less important. There is no doubt that the most important, in all cases where suspicion exists, is the constantly reiterated examination of the patient, either during periods when the clinical symptoms are markedly pronounced, or under provocation of such symptoms by methods similar to those employed by BARCLAY and HURST. As the prognosis is decidedly bad unless the affection is recognised and treated, — many cases terminate lethally owing to perforation to the large vessels or other adjacent organs, — these thorough inspections should be instituted in regard to all patients showing symptoms of an affection in the esophagus, and where the ordinary roentgen examination nevertheless proves negative; as well as in the cases where the routine examination reveals spasm in the esophagus, but gives no

indication of the underlying cause. It is also probable that if we follow JACKSON's example and carry the examination through in respect to all patients with pronounced gastric symptoms and hematemeses, in whom nothing abnormal can be demonstrated in the stomach or duodenum, we should in a number of these be able to demonstrate roentgenologically the existence of a peptic esophageal ulcer, just as he succeeded in doing by direct esophagoscopy.

SUMMARY

Primary diagnosis of peptic ulcer of the esophagus by roentgen examination is much rarer than might be expected, even considering the rarity of the affection. The author reports such a case, in which the diagnosis was established roentgenologically, and points out that in order to obtain the pathognomonic roentgen finding it is particularly important that in suspected cases the examination should be repeated if necessary several times, and preferably during periods with markedly pronounced symptoms, or else under artificial provocation of such symptoms.

ZUSAMMENFASSUNG

Die Diagnose peptisches Ösophagus-Ulkus wird viel seltener primär durch Röntgenuntersuchung gestellt, als man — selbst unter Berücksichtigung der Seltenheit des Leidens — erwarten sollte. Verf. berichtet über einen solchen Fall, in welchem die Diagnose röntgenologisch festgestellt wurde, und betont, dass es für die Erlangung des pathognomischen Röntgenbefundes besonders wichtig ist, in verdächtigen Fällen die Untersuchung zu wiederholen, erforderlichenfalls mehrere Male, und zwar vorzugsweise in Perioden mit deutlich ausgesprochenen Symptomen, oder aber unter künstlicher Hervorrufung solcher Symptome.

RÉSUMÉ

Le diagnostic d'ulcère peptique de l'œsophage, opéré primairement par voie d'examen roentgen, se produit bien plus rarement que l'on pourrait le supposer, même en tenant compte de la rareté de cette affection. L'auteur rapporte un pareil cas, dans lequel le diagnostic fut établi roentgenologiquement, et fait ressortir qu'il est particulièrement important, dans le but de parvenir à une constatation roentgen patho-gnomonique, de répéter l'examen dans les cas suspects plusieurs fois si nécessaire, et, de préférence, pendant les périodes de symptômes particulièrement prononcés, ou bien lors de la provocation artificielle de tels symptômes.

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ON A FUNDAMENTAL PROPERTY OF PLANIGRAPHIC IMAGE-FORMATION[1]

by

R. H. De Waard

Introductory

The procedure of planigraphy has in recent years attracted a great deal of attention. This attention started in 1931 when BARTELINK (1) and ZIEDSES DES PLANTES (2) independent of each other published their first practical results. Yet the principle of the method was not new at that time: it was in 1921 described by BOCAGE (3) in France and later on by several others (4). The papers dealing with it remained however unobserved, and BARTELINK and ZIEDSES DES PLANTES had to invent the method again before it was put into practice.

By the planigraphic procedure radiographs can be obtained which to a certain extent are representations of cross-sections through anatomic structures. These radiographs have proved to be of considerable importance for the investigation of certain pathologic conditions. In various cases however they greatly differ from the sections to which they correspond, and it is clear that in such cases their interpretation is a very difficult matter. This is particularly true when the images are obtained by means of a sort of apparatus (e. g. the »Tomograph» of the El. Ges. Sanitas and the »Planigraph» of the Siemens-Reiniger-Werke) in which a simplification of the planigraphic principle is realised. It therefore seems desirable to submit the said cases to a special examination. In this paper an examination of this kind will be carried out and the characteristic of an important class of cases of planigraphic discrepancy will be investigated.

[1] Submitted for publication July 15, 1938.

1. The principle of the planigraphic procedure

As an introduction to our further considerations we will in this first § explain the principle of the planigraphic procedure.

In fig. 1 a scheme is given of the »Tomograph» of the El. Ges. Sanitas in Berlin which — in 1935 — has been designed by GROSSMANN (5). The object *Ob* lies on a horizontal plane *aa*. During the exposure the focus

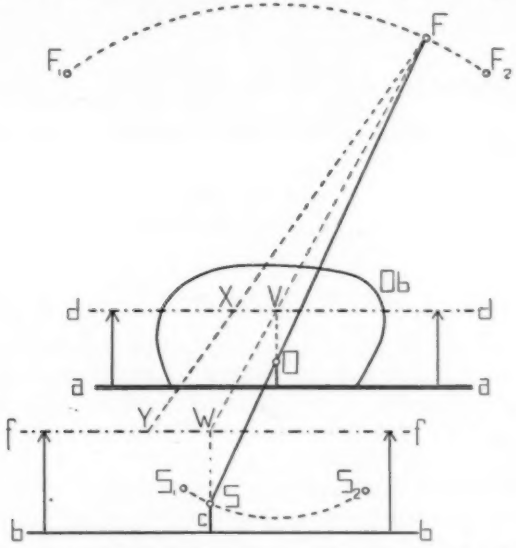

Fig. 1. Scheme of GROSSMANN's tomograph. *Ob* = object, *F* = focus, *ff* = film.

F of the roentgen tube describes the arc of circle F_1F_2 round the centre *O*, and with this movement a definite movement of the film is connected. To describe the latter movement we imagine the straight line *FO* prolonged with a segment *OS*: when then *F* describes the arc F_1F_2 the point *S* will pass through the curve S_2S_1. Now *S* in its course takes along the vertical bar *c* and by this bar it is connected with the horizontal support *bb* for the film.

Let us now assume that the film is situated in a horizontal plane *ff* at a certain distance above *S*. The image which is then obtained will correspond to a definite cross-section *dd* through the object. To determine this cross-section we connect the points *W* and *F* and erect in *O* a perpendicular to *aa* till it meets *WF*. The horizontal line *dd* which passes through the point of intersection *V* then represents the intended cross-section.

The fact that it is just the cross-section *dd* which corresponds to the image on the film is a consequence of the following statements:

1. Any definite point *X* of *dd* is projected in one and the same point *Y* of the film during all the exposure. In the image it is therefore represented by this single point *Y*.

2. Every point *Z* beyond the cross-section *dd* is in the course of the exposure projected in different points of the film. These points are situated on a straight line the length of which is proportional to the distance of *Z* to the section. The point *Z* is therefore represented on the film with a degree of vagueness which is equally proportional to the said distance.

For the point *X* of fig. 1 the first statement can be proved as follows:

According to the conformity of the triangles *FVO* and *FWS* we have

$$FS : FO = FW : FV,$$

and from the conformity of the triangles *FVX* and *FWY* we deduce

$$FW : FV = WY : VX.$$

We thus find

$$FS : FO = WY : VX,$$

and consequently

$$WY = \frac{VX \times FS}{FO}.$$

As in this expression for *WY* the values of *VX*, *FS* and *FO* are independent of the position of *F* the distance *WY* itself will be independent of this position. The point *Y* in which *X* is projected is therefore just as *W* a fixed point of the film.

The given statements suggest the supposition that the planigraph will show a conform image of the cross-section *dd* through the object. This supposition has proved to be correct to a certain degree, and it is from this fact that the planigraphic procedure derives its practical importance. In general however the supposition is inexact. It is based on the view that the vague impressions of points beyond *dd* do not materially affect the total image whereas in reality they often give rise to considerable discrepancies between the image and the section to be represented. Such discrepancies have been pointed to by BRONKHORST (6) and by BURGER and VAN WEEL (7); in the cases considered in the present paper they are particularly striking.

2. A simple example of planigraphic discrepancy

A remarkable case of planigraphic discrepancy occurs in the representation of cross-sections through a sphere. This fact is clearly demonstrated by the set of planigraphs reproduced in fig. 2. These planigraphs are taken of a water-filled roundbottom flask. The image *A* corresponds to a plane through the axis of the flask whilst the images *B*,

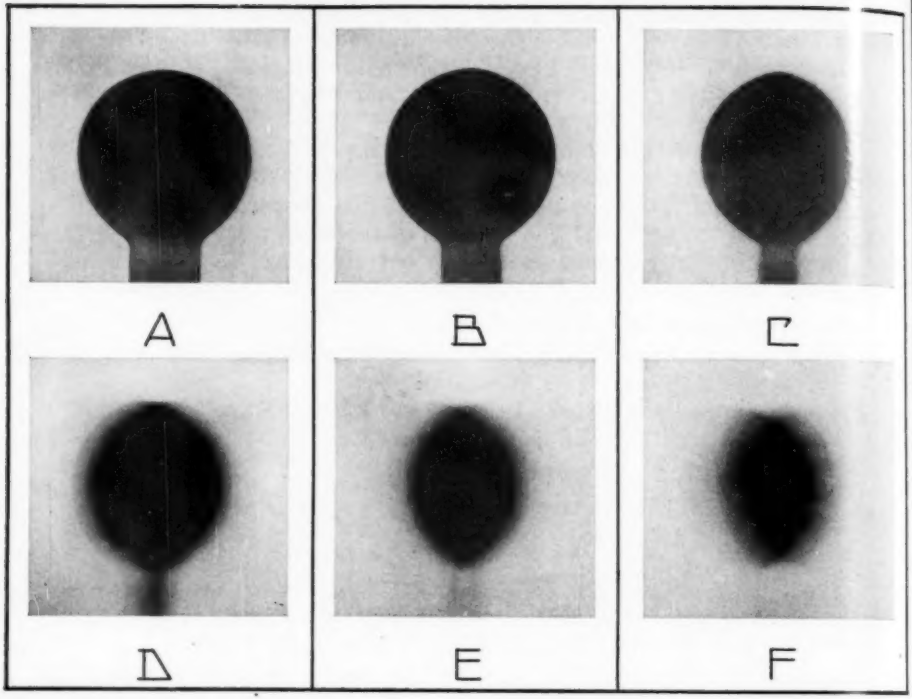

Fig. 2. Planigraphic pictures of 6 parallel cross-sections through a water-filled round-bottom-flask. *A*: cross-section passing through the axis of the flask. *B, C, D, E, F*: cross-sections at distances of 8, 16, 24, 32 and 40 mm. from that of *A*.

C, D, E, F correspond to a set of parallel planes at distances of 8, 16, 24, 32 and 40 mm. from the first.

As the diameter of the spherical part of the recipient measured about 70 mm. the plane at 40 mm. distance from the axis is evidently situated beyond the object. The corresponding planigraph *F* however clearly shows an image and we thus notice that there is a marked discrepancy between object and image. Other discrepancies occur in the planigraphs *B, C, D, E*: as far as the spherical part of the object is concerned those planigraphs correspond to circular cross-sections whilst the images are a sort of ovals and do by no means provide a conform representation. The only planigraph of fig. 2 which shows an approximately conform image of the corresponding cross-section is that denoted by *A*.

We thus see that in the planigraphic representation of cross-sections

through a sphere remarkable discrepancies between the object and the images indeed make their appearance. These discrepancies will be explained later on (in § 7).

4. Description of a simple apparatus for phantom-experiments on planigraphy

It is clear that the planigraphs of fig. 2 might have been obtained by means of one of the standard-apparatus designed for the planigraphic examination of human patients. For phantom work however it is possible to do with much simpler expedients. In order to illustrate this we once more consider fig. 1 in which GROSSMANN's Tomograph is schematically represented.

During the exposure the object *Ob* and the point *O* do not move. The straight line *FOS* however turns round *O*, and the focus *F* and the point *S* thus describe the arcs of circle F_1F_2 and S_2S_1. The bar *c* and the support *bb* for the film perform at the same time a rotation round *S* which makes them displace parallel to themselves. The overlook over these different movements is very much simplified when they are not considered with reference to the non-moving object *Ob*, but to the rotating line *FOS*. Relative to this line the plane *aa* and the object *Ob* turn round an axis through *O* whereas the plane *bb* and the film perform a rotation round a parallel axis through *S*; these two rotational movements are so connected that the planes *aa* and *bb* are forced to be parallel.

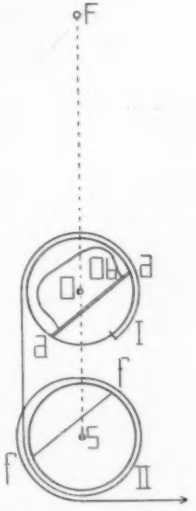

Fig. 3. Two equal turning platforms I and II connected by a piece of string. When in the direction of the arrow a pull is exerted on the string the platforms will rotate with equal angular velocities.

It is therefore obvious that a planigraph which is realised by the mechanism represented in fig. 1 can just as well be obtained when the line *FOS* is kept fixed whilst the object *Ob* and the film are made to turn round parallel axes respectively passing through *O* and *S*: one has only to care that the two rotations always occur with the same angular velocity. Now in practice the latter condition can easily be satisfied. We may for instance make use of two equal turning platforms I and II which move in the same horizontal plane and whose motions are connected by means of a piece of string fitted in the way indicated in fig. 3. We then put the object on platform I and the film in a vertical position on platform II, and we give the roentgen tube a

Fig. 4. Arrangement used for phantom-experiments on planigraphy. The roentgen tube is situated on the left side beyond the picture.

place as to make the focus be situated in the plane passing through the axes of the two platforms. In this way we arrive at an arrangement like that of fig. 4 in which the object is represented by the waterfilled roundbottom-flask mentioned in § 2. It is by this arrangement that the planigraphs of fig. 2 have been obtained. The flask is put upsidedown in a flat waterfilled basin and this basin is placed on platform I in such a way that the axis of the latter is coincident with that of the flask. To obtain a planigraph the only thing to do is then to make the two platforms turn over a certain angle during the exposure.

It is obvious that by means of such an arrangement planigraphs of various sorts of objects can be obtained.

4. Planigraphic pictures of a circular cylinder: theoretical considerations

We will in this § consider in some detail the planigraphic representation of an extremely simple object: a circular cylinder.

This cylinder may be placed on platform I in such a way that the axes of the two coincide. In fig. 5 it is represented by the upper circle. F is in this figure the focus of the roentgen tube, and S denotes the axis of platform II around which the film performs its rotational movement.

To determine the place of the section through the cylinder which corresponds to that of the film ff we proceed in the way shown in § 1: From S we let fall a perpendicular on ff and we connect its foot W with F. We then draw through O a parallel to SW and denote by V its point of intersection with WF. The chord X_1X_2 which passes through this point

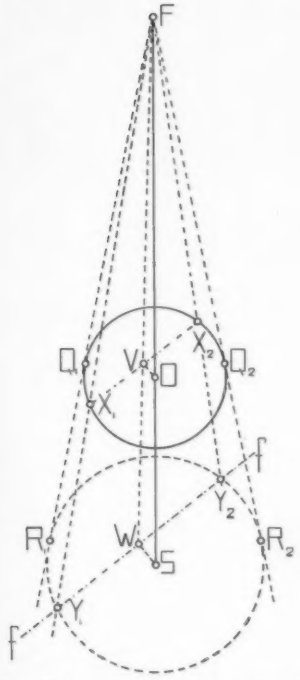

Fig. 5. Scheme of planigraphic image-formation of a cylindrical object (upper circle). F = focus, ff = film corresponding to the cross-section X_1X_2.

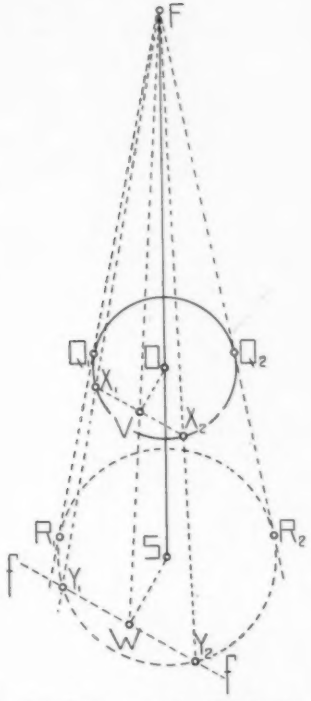

Fig. 6. Scheme as in fig. 5, the film ff corresponding to another cross-section X_1X_2.

and is parallel to ff then represents the cross-section corresponding to the film.

We will now examine how on the film the image is formed. To this end we draw the lines FX_1 and FX_2, and prolonge them till they meet ff. The points of intersection Y_1 and Y_2 are then the images of the points X_1 and X_2 of the borderlines of the cross-section. These images are fixed points of the film and they will consequently describe arcs of circle round S when the platforms I and II perform their rotations. It is obvious that they will do this in the same sense as X_1 and X_2 run through the upper circle, and in the meantime X_1 and Y_1 as well as X_2 and Y_2 will continually be collinear with F. We now denote by Q_1 and Q_2 the points of contact of the upper circle with the tangents to it passing through F. It is then clear that — when in the course of its movement along the

upper circle X_1 (resp. X_2) arrives in Q_1 (resp. Q_2) — the straight line FX_1Y_1 (resp. FX_2Y_2) will not only be a tangent to the upper circle, but as well to the arc of circle described by Y_1 (resp. Y_2). As the centre of the latter arcs is collinear with O and F we may conclude from this that they belong to a single circle which has with the upper circle two common tangents passing through F. The points of contact of these tangents with the lower circle are in fig. 5 denoted by R_1 and R_2. As Y_1 and Y_2 are the images of the borderpoints X_1 and X_2 of the cross-section to which the film corresponds the interval Y_1Y_2 marks the place where the image of the cross-section should be formed. It seems however questionable whether such a formation will really take place, and we will therefore consider this problem in some detail.

It may be noticed that the whole lower circle is situated in the shadow of the upper one. The points of the film between Y_1 and Y_2 can therefore only be reached by roentgenrays which have been impaired by passing through the object. The points on the left of Y_1 and on the right of Y_2 on the contrary are attainable for unimpaired rays and we thus see that there is an essential difference between the points of ff situated inside and those situated outside the interval Y_1Y_2. It is however obvious that in the image this difference will only find its expression when the points on either side of Y_1Y_2 which are attainable for unimpaired roentgenrays are really reached by such rays in the course of the exposure. And this will only occur when during this time Y_1 passes through the point R_1 and Y_2 through the point R_2.

Let us now suppose that in the case represented in fig. 5 the platforms I and II perform rotations of 60° round their axes, and that in their extreme positions a normal erected on the film includes with OF angles of 30°. It is then clear that the above mentioned condition will be fulfilled and that consequently a conform image of the cross section X_1X_2 will be obtained.

In the case represented in fig. 6 however the situation is different. Here the film corresponds to a cross-section whose distance to the axis of the object exceeds three quarters of its radius, and it is easily seen that in this condition the points Y_1 and Y_2 will not pass through R_1 and R_2. This implies that on ff not only the interval Y_1Y_2 will never be reached by unimpaired roentgenrays, but just as well a series of points to either side of this interval. The width of the shadow shown by the planigraph will therefore in this case exceed the distance between Y_1 and Y_2 and the image will accordingly be an inexact representation of the corresponding cross-section.

We thus arrive at the conclusion that planigraphs corresponding to cross-sections close to the axis of the object will indeed provide an ad-

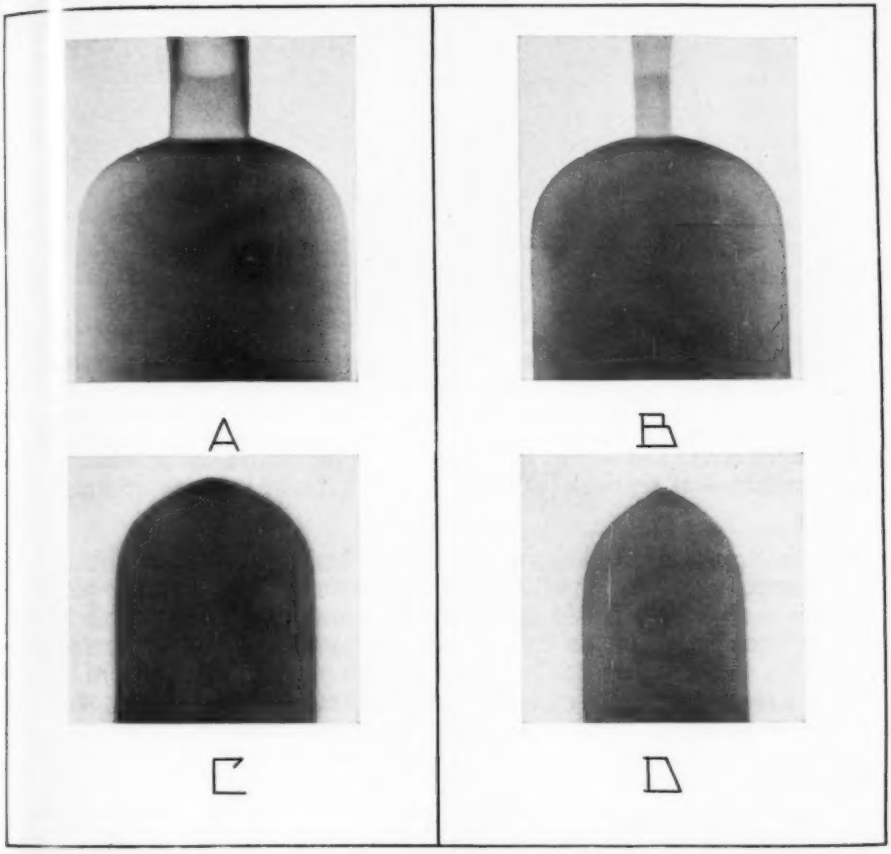

Fig. 7. Planigraphic pictures of 4 parallel cross-sections through a water-filled bottle. *A*: cross-section passing through the axis of the bottle. *B*: cross-section on one side of the former at a distance of 16 mm. *C*, *D*: cross-sections on the other side of the first at distances of 32 and 48 mm.

quate representation, but that those corresponding to more distant sections must show marked discrepancies.

5. Planigraphic pictures of a circular cylinder: experimental verification of the theory

We will now proceed to the experimental verification of the theoretical results just obtained. Such a verification is very much simplified by the

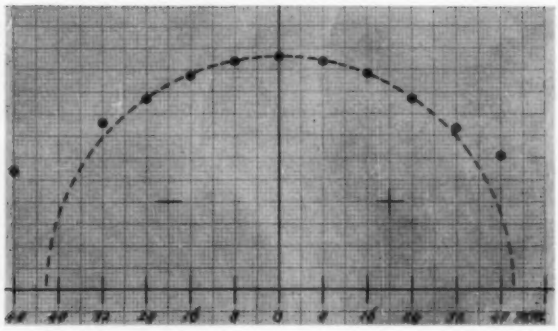

Fig. 8. Graphic representation of the widths of planigraphic images corresponding to a set of vertical cross-sections through a water-filled bottle. The abscissae of the points (o) represent the distances of the different cross-sections to the axis of the bottle whilst the ordinates are proportional to the widths of the corresponding planigraphs. The callibration in such that — when the planigraphic reproduction of the cross-sections had been conform — all the points (o) would have been situated on the dotted semicircle.

fact that a circular cylinder is a rotational body. The axis of this body was supposed to coincide with that of the platform on which it was placed, and it is clear that in this condition a rotation of the platform will have no influence whatever on the course of the roentgen-rays. The image on the film will therefore not be changed when platform I, instead of being turned round its axis, is kept fixed during the exposure. It is consequently possible to obtain planigraphic pictures of the cylinder by imposing a rotational movement to platform II only and by keeping platform I at rest.

In this way a set of such pictures has been obtained which has enabled us to test the results of our theoretical considerations.

The object was the cylindrical part of a water-filled bottle whose diameter measured about 8 cm. One of the planigraphic pictures represents a cross-section through its axis; this picture is reproduced in fig. 7 *A*. The other planigraphs correspond to sections which are parallel to the former and situated on either side of it at distances of 8, 16, 24, 32 and 40 mm. In fig. 7 *B*, *C*, *D* three of these pictures are shown. The arrangement was such as to cause a magnification by projection of about $^5/_4$.[1]

[1] The reproduction was characterised by the following numerical data: The distance of the focus F to the axis of platform I measured 123.2 cm. and that to the axis of platform II 155.4 cm. The magnification by projection accordingly amounted to $\frac{1554}{1232} = 1.\ldots$

In the course of the different exposures the films had accordingly to be placed at distances of 0, 1, 2, 3, 4 and 5 cm. from the axis of platform II. The widths of the different images have now been measured and are in fig. 8 represented in their relation to the corresponding distances of the film to the axis of platform II. The scale of this figure is such that — if the planigraphic reproduction of the different cross-sections had been conform — all the 11 experimental points would have been situated on the dotted semicircle. In reality however the situation of the points ± 4 and $+5$ is very different and we thus see that with regard to the last section there is a marked discrepancy. This is now in perfect accordance with the theoretical results obtained in § 4. For in the course of the exposure the film was indeed turned over an angle of 60°, and it consequently did occur in the cases 0, ± 1, ± 2, and ± 3, that the points Y_1 and Y_2 passed through R_1 and R_2, whilst in the cases ± 4 and $+5$ they did not. For this reason the images on the planigraphs are in the cases ± 4 and $+5$ larger than is in accordance with the dimensions of the corresponding cross-sections. Over and above this the theory postulates that planigraphs corresponding to certain planes beyond the object may show images with well-marked outlines, and this consequence too has been confirmed by experiment; fig. 7 *D* is a reproduction of a planigraph which corresponds to a plane beyond the object, at 4.8 cm. distance from its axis, and it nevertheless shows an image of 5.2 cm. width.

6. Formulation of a fundamental property of planigraphic image-formation

In the cases treated in § 4 and § 5 (fig. 5 and fig. 6) conform representations of cross-sections through the object were only obtained when in the course of the exposure it happened that the points Y_1 and Y_2 passed through R_1 and R_2 respectively. It is however clear that at these moments X_1 and X_2 pass through Q_1 and Q_2 and that the roentgen-rays directed to these points become tangents to the object. We thus see that the borderlines of a cross-section *dd* will only then be adequately represented in the corresponding planigraph when in the course of the exposure the roentgen-rays directed to these borderlines become tangents to the object.

This enunciation can be generalised in a way to make it applicable in more complicate cases.

To this end we imagine that a planigraph is made of a cross-section *d* through the object *Ob* which is represented in fig. 9. The outline of the section is denoted by *g*, and *G* is an arbitrary point of this outline. Let us now draw our attention to the point *G* and to a small segment

$S(G)$ of g surrounding it. We then put the question whether this segment will be clearly represented in the planigraph. This is only possible when a well-defined condition is satisfied: the roentgen-rays directed to G must at some moment of the exposure be in this point tangents to the object. We may express this fact in a somewhat different way. To this end we denote by γ the plane which is tangent to the object in G; the results hitherto obtained then suggest *that an adequate representation of the segment $S(G)$ can only occur when the path described by the focus during the exposure has at least one point in common with the plane γ*. In this enunciation an important property of planigraphic reproduction is expressed. One can hardly expect that it is possible to give a mathematical proof of such a general statement. It can however be verified by testing in special cases, and in § 7 it will be shown to hold in the cases of a spherical and a conic object.

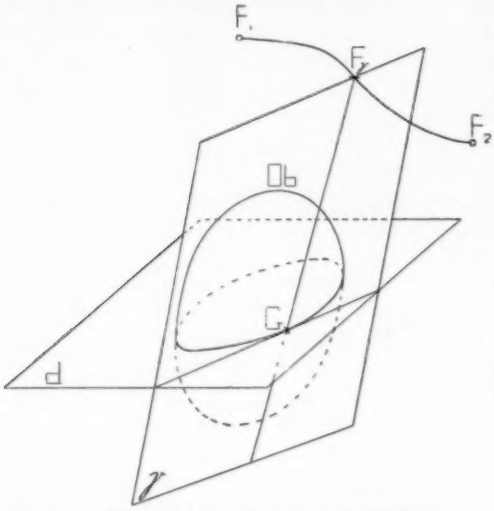

Fig. 9. Ob = object, d = cross-section to be represented by planigraphy. A clear image of the part of the borderline near G can only be obtained when in the course of the exposure the focus F of the roentgen-tube passes through the tangent-plane γ.

7. Planigraphic pictures of a sphere and a circular cone

In § 2 we pointed out that of the planigraphs of fig. 2 only the first specimen shows an approximately conform image of the corresponding cross-section whilst the other five do not. In order to explain this fact we will now consider the image-formation in some detail. As in the case treated in § 4 and § 5 the film was in the course of the exposure turned over an angle of 60°. The axis of rotation of platform II and the film is in fig. 10 denoted by A_{II} whereas F indicates the focus of the roentgen-tube, A_I the axis of platform I, and O the centre of the sphere Ob to be represented. The line connecting F and O is perpendicular to the axis of rotation of the platforms. It is then obvious that the points of contact of the sphere with the roentgen-rays tangent to it are situated on

cir le indicated by the chord Q_1Q_2. We will now assume that in fig. 10 th medium position of the sphere is represented and that the line d inc cates the section which corresponds to the position of the film f. Th outline of this section will then in both its extreme positions appear as he dotted ellipse.

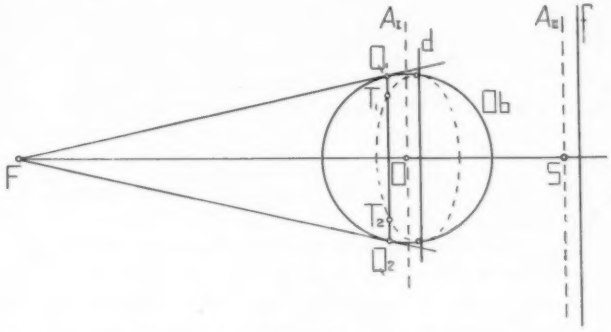

Fig. 10. Arrangement by which a planigraph of the cross-section d through the spherical object Ob can be obtained. F = focus, f = film in its medium-position, A_I and A_{II} = axes of the turning platforms I and II.

Let us now denote by T_1 and T_2 the points of intersection of this ellipse with the chord Q_1Q_2. The arc T_1T_2 then corresponds to two parts t' and t'' of the circular outline of the section under consideration. It is evident that of this outline only the points situated in these parts will in the course of the exposure become points of contact of the object with roentgen-rays tangent to it. After our theory this implies that only the parts t' and t'' will in the planigraph appear as well-marked borderlines. The higher and lower parts of the section will give rise to non-conform images which for the same reasons as in the case of the planigraph of fig. 7 C are wider than would be in accordance with the corresponding dimensions of the cross-section. We thus see that the planigraphic pictures of fig. 2 B, C, D, E have just the character suggested by the theory.

The same is obviously true for the planigraph of fig. 2 F which corresponds to a plane beyond the object and nevertheless shows a well-marked image; this image is formed in the same way as that of fig. 7 D which corresponds to a plane beyond the cylinder considered in § 4 and § 5. Similar pictures as those of the figg. 2 and 7 have in a recent paper been published by BURGER and VAN WEEL (7). The objects were cylindrical, spherical and conic cavities in paraffin-phantoms. The dimensions of the images are not mentioned, but from a qualitative point of view they

are certainly in accordance with our theoretical considerations. This is particularly true for the image of a cone. To illustrate this we imagine that the axis of a cone coincides with that of platform I on which it may be placed. The planigraphic image will then only be conform when it corresponds to a plane through the said axis. Planigraphs corresponding to other sections will show images which are too wide in the region of the summit. The latter feature is now very clearly seen in fig. 1 in the paper by BURGER and VAN WEEL. The authors did however not submit the image-formation to a detailed examination and they thus arrived at an inexact conclusion: their opinion is that only those parts of the outline of a section through an object will be conformly represented in a planigraph in which the surface of the object is perpendicular to the section. We on the contrary were in this paper led to the view that a conform image of an outline of a cross-section may be obtained whenever in the course of the exposure it occurs that the roentgen-rays directed to its points are in these points tangents to the object. This view has been shown to be in accordance both with our own experiments and with the pictures given by BURGER and VAN WEEL.

SUMMARY

Any radiograph obtained by means of the planigraphic procedure corresponds to a definite cross-section through the object examined, and it is often supposed to provide an adequate representation of this cross-section. In the present paper experiments are described by which this supposition has been tested. According to a modification of the principle of GROSSMANN's tomograph a special apparatus for phantom-experiments has been designed by means of which sets of planigraphs have been made of a spherical and of a cylindrical object. The images of most of these planigraphs turned out to be greatly different from the corresponding cross-sections, and they thus made clear that in general the planigraphic procedure does in no way provide adequate representations of such sections.

By a theoretical discussion of the planigraphic image-formation the said differences are then explained; they are shown to be of essential nature and to depend on a criterion of general character.

ZUSAMMENFASSUNG

Jedes planigraphisch aufgenommene Röntgenbild entspricht einem bestimmten Querschnitt des untersuchten Objektes. Man nimmt vielfach an, dass es diesen Querschnitt getreu wiedergibt. Bei den in der vorliegenden Arbeit beschriebenen Versuchen wurde beabsichtigt, diese Annahme einer Prüfung zu unterziehen. Nach dem etwas modifizierten Prinzip des GROSSMANN'schen Tomographen wurde ein Spezialapparat für Phantomversuche hergestellt, mit dem eine Reihe von Planigrammen eines kugelförmigen und eines zylindrischen Objektes angefertigt wurde. Es ergab sich, dass die Mehrzahl der erhaltenen Bilder von den entsprechenden Querschnitten erhebliche Unterschiede aufwies. Daher musste die Schlussfolgerung gezogen werden, dass das planigraphische Verfahren im allgemeinen keine diesen Schnitten entsprechenden Bilder liefert.

Die vorhandenen Unterschiede wurden sodann durch eine theoretische Betrachtung der planigraphischen Bilderzeugung erklärt; sie erwiesen sich von grundsätzlicher Bedeutung indem sie sich durch eine allgemeine Regel bedingt zeigten.

RÉSUMÉ

Toute radiographie obtenue par le procédé planigraphique correspond à une section bien définie de l'objet examiné. On admet souvent qu'elle fournit une image ressemblante de cette section. Les expériences décrites dans l'article ci-dessus ont pour but de mettre à l'épreuve cette présomption.

Suivant une variation du principe du tomographe de GROSSMANN un appareil spécial a été construit pour examiner des fantômes. Au moyen de cet appareil des séries de planigraphies ont été effectuées d'un objet sphérique et d'un objet cylindrique. La plupart des images ainsi obtenues montraient des différences importantes avec les sections correspondantes, ce qui prouve que le procédé planigraphique ne fournit pas en général des images ressemblantes.

Par des considérations théoriques sur la formation des images planigraphiques on explique les différences ainsi trouvées; puisqu'elles sont soumises á une regle générale elles présentent un intérêt fondamental.

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FROM ODENSE TOWN AND COUNTY HOSPITAL, ROENTGENCLINIC (CHIEF: SENIOR PHYSICIAN P. JACOBY) AND THE STATE HOSPITAL, SØNDERBORG, GYNECOLOGIC AND OBSTETRIC CLINIC (CHIEF: SENIOR PHYSICIAN E. PETERSEN)

TWO CASES OF GASTRIC SYPHILIS[1]

by

P. A. Blinkenberg

If we search systematically through the literature on gastric syphilis, going back year by year, for instance, in the American Index, we find that nearly all the published reports of cases have come from the United States, Latin America, China, Japan, Russia, France and North Africa. From this, I think we may conclude that gastric syphilis is found specially in countries where the syphilis morbidity is high, and where the treatment both of the disease itself and of the affected individuals leaves more or less to be desired.

It is difficult of course, to give any statistics of the incidence; the more so as the figures vary with the observer: 1 in 300, 200, 100, etc. of syphilitics. The material of the Mayo Clinic, which has been analysed and published by O'LEARY, MOORE and AUSTIN, and later by EUSTERMAN, is given as 87 undoubted gastric cases among a total of 25 000 syphilitics. Gastric syphilis is more frequent in men than in women, but in the same proportion as syphilis on the whole is more frequent in males than in females. The disease has also been observed in children 12 to 14 years old, with congenital syphilis. As a rule, the patients belong to the age group 20—55 years; most of them are between the ages of 35 and 40.

The symptoms are on the whole only slightly characteristic: dyspepsia, sometimes relieved by the intaking of food; practically never hematemesis or melena; after a time an increasing craving for small, frequent meals. As the disease progresses, the patient will have attacks of vomiting shortly after eating, specially if he has overpassed what experience should have taught him to be the limit of his food-toleration. Gradually he becomes unable to tolerate anything at all, and vomits even liquid food immediately after every meal. The invariable result is emaciation and dehyd a-

[1] Submitted for publication Sept. 20, 1938.

t on. Physical examination seldom reveals any palpable tumor in the a bdomen, and there will often be an extraordinary contrast between the v olent symptoms and extreme emaciation of the patient on the one hand, a d the absence of cachexia on the other.

As already said, the disease is rare. Yet also from the Scandinavian c untries the following few cases have been reported, which I briefly r count here.

In the Acta Medica Scandinavica for 1923, HERNLUND and STRAND-B RG described 5 cases, and came to the following conclusions: (1) if a p tient with syphilis develops symptoms from the stomach, gastric s philis should immediately be suspected; (2) if, in a patient with syphilis, r entgenography reveals a pathologic condition of the stomach reminding o a tumor, so that an operation is contemplated, intense antiluetic treatm ent should first be given for some time; (3) if a patient has an affection o the stomach, and the roentgenologic diagnosis is uncertain and ordin ry diet therapy without effect, the possibility of syphilis should be thought of.

In 1926, WIDERØ reported the case of a man, age 35, extremely emaciated and suffering from hunger pains, nausea and dolor, on whom an operation was performed with resection of a large ulcus in the pyloric canal. At the operation other ulcers were observed in various parts of the stomach. The patient made a good recovery, but four years later he was again admitted to the same hospital with a swelling on the right leg, which proved to be a gumma (Wassermann reaction was positive), and it was now suddenly realised that the affection in the stomach was gastric syphilis.

In 1928, BRODERSEN reported the case of a woman, age 32, who in 1924 was admitted to hospital, having suffered for three years from dyspepsia, and lately emaciation. Roentgen examination revealed a severe stenosis or spasm in the region of the pylorus and pyloric canal — but four and a half hours after meal the stomach was empty. An exploratory laparotomy showed the pylorus and the adjacent part of the pyloric canal somewhat thickened, but no lesion or cicatrix. The patient was given ordinary medicinal treatment, but returned four years later, now extremely emaciated, vomiting all food immediately after ingestion. Roentgen examination now showed an hour-glass stomach, the shape of a dumbbell, and there was marked retention. Resection was done, and there was found to be a long, narrow central stenosis of the organ. The microscopic examination showed chronic inflammation. The Wassermann reaction was positive, and with that the diagnosis was established.

Of the two cases which I myself am able to report, I owe the first to the courtesy of senior physician, Dr. EKKERT PETERSEN, Sønderborg. Briefly, the history is as follows:

Fig. 1.

Fig. 2.

Fig. 3.

Fig. 4.

The patient, a woman, age 28, wife of a fisherman, was admitted to the hospital in July, 1927, for a burn on her foot. At the same time she complained of pains of varying duration, from 15 to 30 minutes, in the cardia. Occasional vomiting, but no hematemesis or nausea. Wassermann reaction was positive. Laboratory tests showed achylia, rather considerable 6 hours' retention, no melena. Roentgen examination revealed a large defect in the pyloric canal, but 4 hours after meal the stomach was empty. Ulcus cure and antiluetic treatment were instituted. As there continued to be retention, and the patient continued to complain of cardiac attacks, a laparotomy was done on July 6th, 1927. In the pyloric canal was found a large infiltration resembling a tumor; only small nodes. Gastric syphilis was diagnosed, and a gastroenterostomy performed. Microscopy showed simple inflammation. The specific therapy was continued with. In 1937, the patient entered the hospital again for other causes; in the meantime she had at different times received antiluetic treatment, and the Wassermann reaction was now negative. A roentgen examination showed that the anastomosis functioned well, but the filling of the pyloric canal was still deficient. (Fig. I.)

The other case came under my own observation.

The patient, a woman, age 44, was admitted to the Odense Town and County Hospital in the fall of 1937. She had never been pregnant. As a child, she had been for four months in a sanatorium for children, otherwise she had always been in good health until her present disease began, three months before her admission. At that time she had commenced to feel nausea after meals, and after a while to be seized with vomiting right after eating. As soon as the vomiting had ceased she always felt completely well again, however, and never had any pain; it was simply »as if her stomach was too small». For a couple of months past she had felt something like a lump in her abdomen. At the same time her bowels had become more and more sluggish, and lately she had had difficulty in micturating. In the three months that she had had symptoms from the stomach, she had lost nearly 20 pounds in weight. On physical examination a tumor, the size of a child's head, could be felt in the right iliac fossa. Exploration proved it to be an ovarian cyst. Perhaps there was also a resistance in the depth of the epigastrium. During the observation in the hospital no relation could be demonstrated between her subjective complaints and the tumor in the abdomen.

The patient was now turned over to me for roentgen examination. My report of the findings was as follows: Stomach full of fluid (she has drunk water this morning). Swallowing natural. Esophagus natural. Complete pyloristenosis, the pyloric canal being represented only by a faintly visible tenon-shaped barium shadow. No perceptible peristalsis or evacuation; 6 hours after meal nearly all the barium still remains in the stomach; probably also remnants of food there. Conclusion: the patient has an almost complete pyloristenosis, probably determined by cancer in the pyloric canal. (Fig. 2, 3, 4.)

There was no blood in the feces. An operation was then performed, at which the liver was found to be completely diseased. There was a luetic cirrhosis, — a »hepar lobatum» Around the canalis egestorius the stomach wall was swollen to the size of a hen's egg, but there was no sign of invasion into the adjacent parts, and only a few swollen glands. Resection was done, and the patient soon recovered from the operation. The preparation showed that large portions of the pyloric canal were, as it were, denuded of cover epithelium, and the submucosa very much thickened (fig. 5). Already at the operation gastric syphilis was diagnosed, on account of the curious finding and the condition of the liver. Subsequent microscopy showed simple inflammation, with absence of cover epithelium and no sign of cancer anywhere. Later, questioning of the patient elicited the fact that in her youth she had had syphilis, for which she had been treated with injections. Wassermann, + 15; Kahn, + 13.

Fig. 5.

The cases referred to, and the two here reported, all show the same characteristic picture of a constriction of the pylorus and pyloric canal, which in extreme cases may become complete and simulate cancer.

From the pathoanatomical viewpoint the disease is dealt with by several writers. KAUFFMANN (ed. 1911) says that it is uncommon; that gummatous infiltrates due to obliterant angiitis are found in the submucosa; and that the lesions have a tendency to heal spontaneously, with formation of cancellous tissue and the shrinking characteristic for the latter, which results in stenosis, or even complete occlusion, of the canal and pylorus (cf. hepar lobatum). HAUSSMANN has a more detailed division; and HERNLUND and STRANDBERG recognise three types of gastric syphilis: a) syphilitic gastritis, — an enanthema corresponding to exanthema; b) syphilitic gastric ulcer, — a lesion developed from a gumma and characterised by the fact that the loss of substance is from the mucosa alone, while the submucosa is enormously thickened; c) pseudo-tumor formation, — due to the tendency of the diffuse gummatous infiltrations to heal with formation of shrinking cancellous tissue, so that the form of the stomach is altered. The result may then be either a tumor-like infiltration of the pyloric canal or, through constriction of the sinus and body, »hour-glass» stomach; in extreme cases »leather-bottle» stomach such as is seen in cases of plastic linitis. Of the cases recounted in the foregoing, the first comes under group b, the two others under group c.

To these diverse pathoanatomical characteristics correspond very marked roentgenological changes in the form of the stomach. According to SCHINTZ's well known textbook (both editions) it should not be possible, however, to diagnose a case of gastric syphilis from the roentgenological findings. KOEHLER expresses himself to the same effect. PANNER merely says that syphilis may probably produce shadow defects in the stomach.

The largest case material dealt with from the roentgenological viewpoint is that of the Mayo Clinic, published in 1928 by MOORE and AURELIUS. They group the cases into three types: prepyloric, dumb-bell stomach and leather-bottle stomach, probably corresponding simply to different degrees of the advancing disease, and represented in their

material by respectively about three-fourths, one-fourths and one-tenth of the cases.

The diagnosis is difficult, though with our increasing experience less so than before. According to the publications of the Mayo Clinic it should be possible to make it roentgenologically in about 50 per cent of cases. The pathologic conditions apt to give similar pictures are certain forms of juxtapyloric ulcer, spasm, erosion, cancer — specially cirrhous, tuberculosis and, finally, the much debated Brinton's disease (plastic linitis). According to MOORE and AURELIUS, EUSTERMANN and LE WALD, the chief roentgenologic signs are:

a) a concentric, symmetric filling defect affecting both curvatures equally; the margin of the contracted lumen quite smooth; the stomach not adherent to the adjacent parts as in cases of ulcus and cancer.

b) dumb-bell shape of the stomach; i. e. division of the organ into two pouches connected with a rather long, narrow canal (in contrast both to the hour-glass stomach resulting from an ulcer, which is often B-shaped, with a very narrow, but short, canal between the two divisions, and shortened lesser curvature; and to the similar condition in cancer, where the form of the connecting canal is usually more or less irregular).

c) usually, except in extreme cases (pyloristenosis, leather-bottle stomach), a lack of relation of the patient's general physical condition to the serious roentgenologic findings.

Prolonged application of intensive specific therapy will nearly always relieve the patient's symptoms, and will also in a great many cases cause the process in the stomach to regress.

SUMMARY

The author reports 2 cases of gastric syphilis observed in Denmark within the last ten years. This brings the total number of cases of this disease reported from the Scandinavian countries (Sweden, Norway and Denmark) in the last fifteen years up to 9. The roentgenologists should therefore realise that syphilis in that site is not altogether rare; and specially should this be borne in mind when the roentgen findings seem to be in reverse proportion to the patient's general condition.

ZUSAMMENFASSUNG

Verf. berichtet über 2 Fälle von gastrischer Syphilis, die in den letzten 10 Jahren in Dänemark beobachtet wurden. Dies bringt die Gesamtzahl der im Laufe der letzten fünfzehn Jahre in den skandinavischen Ländern (Schweden, Norwegen und Dänemark) mitgeteilten Fälle dieser Krankheit auf 9. Die Röntgenologen sollten sich daher gegenwärtig halten, dass Syphilis in dieser Lokalisation nicht ganz selten ist, und sich dieses Verhaltens ganz besonders dann erinnern, wenn die röntgenologischen Befunde im umgekehrten Verhältnis zum Allgemeinzustande des Patienten zu stehen scheinen.

RÉSUMÉ

L'auteur rapporte 2 cas de syphilis gastrique, observés au Danemark au cours de ces dix dernières années. Ceci porte à 9 le nombre total des cas de cette affection rapportés dans les pays scandinaves (Suède, Norvège et Danemark) au cours de ces quinze dernières années. Les roentgenologues devraient donc se rendre compte de ce que la syphilis ainsi localisée n'est pas tout-à-fait rare, ainsi qu'avoir cette circonstance spécialement en mémoire, lorsque les constatations roentgenologiques paraissent être à l'inverse de l'état général du sujet.

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FROM THE ROENTGEN CLINIC OF THE AARHUS MUNICIPAL HOSPITAL AND THE RADIUM CENTRE FOR JUTLAND (CHIEF: CARL KREBS. M. D.)

NOTES ON MYELOMA[1]

by

Jørgen Bichel[2] and *Poul Kirketerp*

To the general conception, myeloma is always *multiple*. In GESCHICKTER and COPELAND's large text-book on tumors of bone, for instance, if we wish to find: myeloma, we must look in the register under the key-word: Multiple —. The apparent unconditionality of the adjective could hardly be expressed more clearly. In recent years, multiple myeloma has come to be considered more and more as a constituent element of a systemic disease, myelomatosis; and since in sternal puncture a means has been found of examining the bone marrow of living subjects, several cases of myelomatosis have been published, in which the only signs of the disease were cachexia, blood changes, and perhaps the presence of Bence-Jones protein in the urine; while roentgenologically demonstrable bone changes were absent. Sternal puncture, however, revealed the nature of the disease, the bone marrow being found diffusely inseminated with myeloma cells (plasma cells).

Opposed to the modern conception of myeloma as a systemic disease is the fact that cases have been published in which either the clinical course, terminating in complete cure after treatment of the lesion, or necropsy with careful scrutiny of the bone system, showed such tumors — arisen from the bone marrow and composed of typical plasma cells — to be actually solitary growths. Not only a theoretical, but a clinical interest attaches to the question whether myeloma primarily occurs as a solitary tumor, which subsequently metastasises, or whether the lesion from its incipiency represents a systemic disease (myelomatosis). If the origin of myelomas is invariably multicentric, it is evident that there can be no such thing as »solitary myelomas». But if their origin is unicentric, and the generalisation a subsequent development, it should be possible

[1] Read at the meeting of the Northern Association for Medical Radiology, Copenhagen, June 1938. — Submitted for publication, July 1938.

[2] Lady Tata Memorial scholar.

to observe and deal with the single tumor, provided the diagnosis is made sufficiently early, even if the metastasis sets in very rapidly.

The problem of solitary myelomas has been the subject of considerable discussion (WALLGREN, MAGNUS LEVY, GESCHICKTER and COPELAND, et al.). Many authors hold their occurrence to have been proved, while others object that in most of the cases on which that proof is supposed to rest, either the investigation has not been sufficiently thorough, or the observation period too short, to warrant a positive conclusion.

If we review the literature, we find that many cases reported as solitary myeloma may at once be eliminated, because they were not so thoroughly investigated that the possibility of a generalised process can be with certainty excluded. In most of the instances where such a case of myeloma with a solitary focus has been supposed to exist, the patients were individuals who had for some time been suffering from neuralgiform or rheumatic pains, and in whom roentgenography then revealed a destructive process in a bone. Others had been examined owing to spontaneous fractures. In either case it would generally be impossible for the roentgenographer to determine the nature of the bone disease responsible for the lesion. In most cases there has been a roentgen diagnosis of osteoma, as a rule with the additional observation: giant cell tumor. Then a biopsy has usually been made, and when the histologic diagnosis has been: myeloma, the entire skeleton has been roentgenographed; and when after a shorter or longer time no other roentgenologically demonstrable foci were found, the case has been set down as »solitary myeloma». This procedure is open to several errors, however. In the first place, the fact that there are no other roentgenologically demonstrable foci does not make it absolutely certain that such foci do not exist nevertheless; in several cases, necropsy has revealed bone foci that were invisible in the roentgenographs (GRUENEIS, GESCHICKTER and COPELAND). Secondly, there are cases of myelomatosis in which there are absolutely no changes in the osseous structure, but only in the bone marrow (TRANBØL). It is contrary to reason to speak of »solitary myeloma» where there is diffuse myelomatosis of the marrow, even if there be only a single roentgenologically demonstrable bone focus.

In the Radium Centre for Jutland we recently had two cases which might easily have been set down as solitary myeloma because, with the methods of examination employed up to then, only a single bone focus could be found. In both cases sternal puncture enabled us, however, to show that the tumors were elements of a generalised myelomatosis. This gave us the idea of reviewing all the cases hitherto reported in the literature as solitary myeloma, with the object of finding out if examination of the bone marrow might not have proved them, too, to be systemic.

A collection of twenty cases — 13 from the literature and 7 from the Bone Registry of the American College of Surgeons — was published in 1936 by CUTLER, BUSCHKE and CANTRIL. But as these authors seem to take it for granted that a negative result of the roentgenography excludes myelomatosis; and as, besides, 5 of the 7 from the Bone Registry became clinically generalised within a few months after the primary tumor had been observed, we felt all the more urged to carry our investigation through.

Besides the cases already registered by CUTLER, BUSCHKE and CANTRIL, we have found in the literature available to us 10 others of supposedly solitary myeloma. This entire material we will now scrutinise.

Case 1 (SHAW). — Man, age 29. Health hitherto good. For some time past weakness and pain in the right arm. Then fracture of the right humerus as result of rather severe trauma. One week later, roentgenography revealed a central tumor at the site of the fracture. Skeletal roentgen examination failed to reveal other lesions. A biopsy showed plasma cell myeloma. Curettage was done, and a bridge from tibia inserted. Twelve months later the function was good; there was still some rarefaction, but diminishing. Several examinations of the urine failed to show Bence-Jones protein. Eight years later, in 1931, a personal communication from SHAW to CUTLER, BUSCHKE and CANTRIL stated that the patient was well, with no signs of local recurrence or generalised myelomatosis. No examination of the bone marrow.

The long period of observation — 8 years — makes it probable that the case was one of true solitary myeloma.

Case 2 (ROGERS). — Man, age 34. In November, 1927, he slipped while walking in the street, and fractured the shaft of his right femur. Was given extension treatment and massage for a month. Then he suffered another, slight trauma, following which swelling and pain occurred at the site of the old fracture. Roentgen examination now revealed at that site a structure resembling a giant cell tumour. In June, 1928, curettage was done and radium needles inserted. The pathological diagnosis was now plasma cell myeloma. Skeletal roentgen examination failed to disclose anything abnormal. In November, same year, purulent secretion from the focus necessitated a second operation. Microscopy now showed a structureless matrix with fibrous and vascular granulation tissue, with streaks of plasma cells and lymphocytes. In January, 1929, granulation tissue was removed from the cavity. In the following month it became necessary to amputate the femur owing to suppuration. Microscopy now showed complete necrosis, except of areas which were fibrously transformed and contained material as in chronic inflammation. According to information obtained by CUTLER, BUSCHKE and CANTRIL, the patient was alive in 1932, at which time he was in good health and without signs of recurrence or generalisation. The urine contained no Bence-Jones protein.

Though there was no examination of the bone marrow, the long observation time of 5 years makes it reasonable to suppose that the case was one of true, solitary myeloma.

Case 3 (ZDANSKY). — Woman, age 64, with heart disease, edemas and joint pains of 1 year's duration. Also nephrosis, intense albuminuria (?Bence-Jones) and thrombo-

penic purpura (70,000 platelets). As she complained of severe pain in the right l g, a roentgenograph was taken, which showed a tumor in the upper third of the left fe ur. No roentgenologically demonstrable changes in the other parts of the skeleton. A few days after, pathological fracture of the femur occurred, and a week thereafter the pa ient died from heart disease. Necropsy showed the tumor to be composed of plasma ce s in lively mitosis. The yellow marrow in the long bones had become partly replaced by red. There was amyloidosis of the heart and kidneys, with shrinking of the latter. The communication does not state whether the necropsy included examination of the co tae, sternum and pelvis; nor is there any reference to microscopy of the pathologic red l one marrow.[1]

The necropsy report is so lacking in particulars that diffuse myelomatosis cannot be excluded. In cases of the latter, red marrow is found in the long bones; but it must be admitted that in the present case the condition may perhaps have been due to the hemorrhagic diathesis. It should be noted, though, that reports exist of cases of multiple myeloma accompanied by thrombopenia, and that also amyloid kidney is often seen in connexion with that form of the disease.

Case 4 (WALLGREN). — Woman, age 41. Hemoptysis, acute articular rheumatism with cardiac complications and struma, in the anamnesis. Since the age of 30 carious teeth in the upper jaw. In June, 1918, she removed a couple of small bone splinters herself, from the posterior part of the right superior maxilla. In December, same year, she noticed at the same site, in the lateral side of the gum, a pea-sized nodule, which gradually grew to the size of a walnut. On palpation, a crepitation was heard, but the tumor was indolent. Roentgen examination in April, 1919, revealed a destruction half the size of a plum. Roentgen examination of the rest of the skeleton showed nothing abnormal. The urine contained Bence-Jones protein. Currettage was done. Microscopy showed plasma cell myeloma.

WALLGREN himself is somewhat in doubt as regards the diagnosis, but thinks it must be a myeloma, specially as the urine contained Bence-Jones protein.

Case 5 (LIEBMAN and GOLDMAN). — Man, age 50. Has suffered for five years from a sensation of cold in the right leg from knee to ankle. For the last six months prior to examination pain in the right lumbar region and increasing severe pain in the entire right lower extremity. Roentgen examination revealed a large cystic tumor in the right wing of the iliac bone. Nothing abnormal in the other bones. The roentgen diagnosis was giant cell tumor. Biopsy gave the diagnosis plasma cell myeloma. Deep roentgen therapy was applied with no roentgenologically demonstrable effect on the process, but bettered the patient' condition clinically, so that he was able to walk. Eighteen months after, he still had pains, but his general condition had not deteriorated, and he had not lost weight. The urine did not contain Bence-Jones protein.

This case was only observed for a little under 18 months; too short a time to determine whether the process was solitary or generalised.

[1] ZDANSKY's communication deals chiefly with the roentgenologic picture. From the clinical viewpoint, the case is said to have been discussed by DONATH at a meeting of the Gesellschaft f. innere Medizin u. Kinderheilkunde in Vienna, on Feb. 17th, 19 ?; but of this discussion we have been unable to obtain any report.

Case 6 (MARTIN, DECHAUME and LEVRAT). — Woman, age 56, formerly in good health. For four months increasing pain in the left hip, finally compelling her to keep her bed. The roentgenograph showed a tumor in the left collum femoris. Exarticulation of left hip joint was performed, and the patient recovered. Microscopy showed typical plasma cell cytoma. No Bence-Jones protein in the urine after the operation. Twenty-six months after, she was in perfectly good health.

This case is not convincing. In the first place, the period of observation is too short; secondly, there was no skeletal roentgen examination.

Case 7 (CHESTERMAN). — Man, age 39. During the period April to June, 1935, he sustained repeated traumata to the left tibia, each time resulting in swelling and pain. Roentgen examination revealed a fracture at a point between the upper and middle third of the bone. Biopsy showed a round cell tumor composed of large cells, supposedly plasma cells. Amputation was performed. In December, same year, the patient was in good general condition. No Bence-Jones protein in the urine.

It does not appear from the report that any complete roentgen examination of the skeleton was made. Besides, the period of observation was only 3 months.

Case 8 (DICKSON WRIGHT). — Man, age 31. In April, 1936, walking began to cause him increasing pain and fatigue. In the course of 6 weeks complete paralysis of the lower extremities developed, with loss of sensation from the eleventh thoracic segment downwards. Roentgen examination revealed destruction of the body of the eighth thoracic vertebra. In June, same year, laminectomy was done. The tumor was situated anteriorly from the medulla, arising from the body of the eighth thoracic vertebra, which it replaced. It was soft and pulsating, and was removed with a sharp spoon. There was very abundant hemorrhage. A plaster bandage was applied. In July, same year, radium needles were inserted into the tumor, after which the patient's condition steadily improved. In April, 1937, it was stated to be practically normal. Microscopy showed plasma cell myeloma. Complete skiagrams showed no deposits in other bones. No Bence-Jones protein was found in the urine.

Also of this case it must be said that it may very well have been a case of generalised myeloma, as the observation period is too short.

Case 9 (POLSON and SHIRES). — Man, age 72. Pain of two weeks' duration in left leg. Slipped on stairs and sustained a fracture of the left femur, midways. Died shortly afterwards with ileus. At necropsy, greyish-red tumor masses were found at the site of the fracture. The rest of the skeleton was not examined, but the authors of the communication nevertheless believe the case to have been one of solitary myeloma, owing to its resemblance to other cases reported in the literature. There is no mention of Bence-Jones protein.

Of course, this case cannot be cited as a positive one of solitary myeloma.

Case 10 (ROSSELET and DECKER). — Man, age 55. Formerly in good health. On October 31st, 1931, he slipped on a stone and hurt his left shoulder. For several weeks after, his neck was stiff and painful. Roentgen examination on November 11th revealed a destruction of the fifth to seventh cervical vertebrae. In the course of the

following year, increasing compression symptoms developed, ending in tetraplegia. In January, 1933, an operation was performed, which showed a tumor arisen from the cervical vertebrae, infiltrating the musculature and compressing the dura. Part of this was scraped out, and the patient was given roentgen treatment, which was repeated some times during the following year, with excellent effect. In the fall of 1935 he went to work again, and at the time of the report he was in perfectly good health. Bence-Jones protein is not mentioned.

This case shows the excellent effect of the roentgen treatment, but cannot with certainty be considered as one of solitary myeloma. The skeleton was not roentgenographed throughout, and the observation period is not long enough.

Case 11 (PEYTON). — Man, age 49. Began to have pain in the upper abdomen 1 year prior to the examination, and later considerable weakness in both legs. At the time of admission in July, 1930, roentgen examination of the spine showed the sixth thoracic vertebra to be compressed. There was calcareous atrophy, and the intervertebral disc between the fifth and sixth thoracic vertebrae was obliterated. Roentgen examination of lungs and ribs was negative. The urine was not tested for Bence-Jones protein. Laminectomy was done, and tumor masses found in the lamina and in the transverse process of the sixth thoracic vertebra. Also the head and neck of the sixth rib were replaced by tumor masses. Radium needles were inserted, and later the patient received roentgen therapy, with the result that the symptoms gradually disappeared. Microscopy showed plasma cell myeloma. Skeletal roentgenography in March, 1932, did not reveal additional lesions, but at this time the urine contained Bence-Jones protein. In February, 1934, there were numerous bone foci. According to information obtained by CUTLER, BUSCHKE and CANTRIL he died in March, same year.

This is an example of the cases that begin as apparently solitary myeloma and later become generalised. It would have been of great theoretical interest to have had some bone marrow examinations from the various stages of the disease. CUTLER, BUSCHKE and CANTRIL recount yet another, similar case observed by PEYTON. The patient was a woman, age 38, with a tumor of the left parietal bone. Six months after the first examination it had become generalised, and 1 year and 9 months later the patient died with generalised myelomatosis. Microscopy showed plasma cell myeloma. Also CUTLER, BUSCHKE and CANTRIL's case no. 14 is similar. There was an apparently solitary myeloma in the right femur, and 2 years later the patient died with generalised myelomatosis. At first the urine contained no Bence-Jones protein; later, prior to death, it was present.

Case 12 (HARDING and KIMBALL). — Man, age 60. In January, 1930, without any preceding trauma, he complained of increasing dull, aching pain in the left hip. In June, same year, pathological fracture of the left femur occurred right below the lesser trochanter. As the roentgenographic appearance was that of an osteolytic tumor at the site of the fracture, he was given a bandage which permitted walking. In September, 1931, as the pain had become excruciating, a disarticulation of the leg at the hip joint was performed, but the patient died in surgical shock. At necropsy a bone tumor in the

upper part of the left femur was found. It had destroyed the cortex and invaded the musculature. Microscopy showed typical plasma cell myeloma. The bones were examined grossly and microscopically, but no other foci found. The urine did not contain Bence-Jones protein. Blood: Sahli, 90; red corpuscles, 4.4 millions; white, 5,000; differential count, normal.

This seems to have been a true case of solitary myeloma, as the entire bone system was examined microscopically.

Case 13 (MATHIAS). — Man, age 65, noticed a slowly increasing tumor in his right parietal bone. After roentgen therapy had been given without effect, the tumor, adherent to the dura, was excised in apparently sound tissue. Microscopy showed plasma cell myeloma. The urine was negative for Bence-Jones protein. Eighteen months later the patient was in good health. According to a personal communication to us from Dr. MATHIAS, clinical generalisation occurred 18 months after his communication had been published.

Also in this case investigations are lacking which would prove the lesion to have been originally solitary.

Case 14 (WALTHARD). — Man, age 55. In August, 1922, without preceding trauma, he noted pain in the back of the neck. In May, 1923, a compression syndroma developed, with paralysis of the extremities. In June, same year, a laminectomy was performed, which showed that the seventh cervical and the first thoracic vertebrae were destroyed and transformed into greyish-red tumor masses, which compressed the spinal marrow. A quantity of tumor tissue was removed with a sharp spoon. A few hours after the operation the patient suddenly died. Roentgen examination prior to the operation had failed to reveal anything wrong in regard to the spine. At necropsy it was found that the seventh cervical and the first thoracic vertebrae had been replaced by tumor tissue, so that only a paper-thin bone wall remained. Otherwise the necropsy revealed nothing abnormal. Of other bones, only the vertebrae are mentioned, which were normal. Also the kidneys and heart were normal. Microscopy showed typical plasma cell myeloma with infiltrative growth into the musculature. Bence-Jones protein was not reported. There was no microscopical examination of the other bones at necropsy.

Unfortunately the examination of the bones at necropsy was not so thorough that myelomatosis can be excluded.

Case 15 (BAILEY). — Man, age 65. Admitted to hospital in July, 1929, owing to pain in his right arm. Ten years before this he had fallen and hurt his right shoulder, and for 1 year prior to admission he had suffered from rheumatic pain in that locality. Roentgen examination now showed a process involving the entire shaft of the humerus, which was diagnosed as osteomyelitis. In August, same year, after increasing pain, pathological fracture occurred in the upper third of the humerus, and albuminuria was found, though without Bence-Jones protein. A biopsy now showed a tumor very rich in cells. These were small round cells, with prominent, highly colored nuclei, sparse cytoplasm and many mitoses. The preparation was examined microscopically by EWING, who at first held it to be a carcinoma, on account of the alveolar arrangement of the cells in some places; but on further scrutiny he came to the conclusion that it was more likely a plasma cell myeloma, because in places the cells had the typical character of plasma cells. After strong roentgen treatment the patient's pain disappeared, and the roentgenological picture became practically normal. Six years after, roentgenographs showed the process

to be healed, and the patient was »in excellent condition». The urine did not contain Bence-Jones protein.

This case is interesting on account of the long period of observation. It is hardly to be thought that a generalised process should have failed to manifest itself by symptoms during so long a time. The weak point is perhaps the microscopy. The cells are not described as plasma cells, at all. Yet, the histologist was so acknowledged an authority as Ewing; and if his first supposition, that it was a carcinoma metastasis, had been correct, the primary tumor would in all probability have produced symptoms in the course of the six years.

Case 16 (Charbonnier and Mermod). — Woman, age 62, slipped in her bathroom and sustained a fracture of the upper third of the left femur. Before this she had for some months complained of rheumatic pain in the left thigh. Roentgen examination showed calcareous atrophy and a cystic rarefaction at the site of the fracture. Extension treatment was applied, but shortly afterwards a second fracture occurred. A biopsy showed plasma cell myeloma. Gradually a decubitus developed, with fistula formation to the intestine. Five months after the spontaneous fracture she died. At the necropsy, the entire skeleton was examined, and samples of the bone marrow taken for microscopy from various sites. In no other place were foci of myeloma found. The urine was negative for Bence-Jones protein. This case has also been reported by Rutishauser.

The case is undoubtedly one of solitary myeloma. All the examinations requisite for a sure diagnosis were made. Askanazi, who did the microscopy, prefers the term myelosarcoma for this case, however; on account of the large infiltration of cells into the musculature. The communication is accompanied by a photomicrograph, which shows typical plasma cells.

Cases 17 and 18 (Coley). — This author reports two cases of supposedly solitary myeloma: 1) a woman, age 52, complained of pain in the right leg of 3 years' duration. Roentgen examination revealed a lesion resembling fibrous osteitis or a giant cell sarcoma. She was given roentgen therapy, and 3 years later she was free from symptoms. 2) a man, age 48, with myeloma in the femur was treated with roentgen. Three years after the treatment he was well.

Coley's case histories are so brief that it is impossible to form any picture of the course of the disease. He does not mention roentgenography of bones other than those directly involved, nor examinations of blood or urine.

Case 19 (Arce). — Woman, age 58. A trauma to her left elbow region was followed by increasing pain and swelling. Eleven months after, a roentgen examination showed complete destruction of the distal one-fourth of the right humerus. An operation was done, the epiphysis and the distal portion of the humerus being removed in sound tissue. Microscopy showed plasma cell myeloma. One year after the operation the patient was in good health.

Unfortunately the original communication of this case has not been accessible to us. The observation period was only 1 year.

Case 20 (GESCHICKTER). — Man, age 45, complained of pain in the left thigh of 2 months' duration, and had begun to limp. The pain had begun on an occasion when he lifted a heavy pile of dishes. Roentgenographs of the femur revealed a cystic tumor in the upper part of the shaft. Curettage was done. Microscopy showed plasma cell myeloma. Pathological fracture occurred immediately after the operation. Five months later there was beginning generalisation, on which neither roentgen therapy nor Coley's fluid had any effect. Roentgen examination of the rest of the skeleton was negative. The urine did not contain Bence-Jones protein.

The time between the first symptoms of the tumor and the observation of clinical generalisation was only 7 months.

Of the seven cases found by CUTLER, BUSCHKE and CANTRIL in the Bone Registry of the American College of Surgeons only one, or two at most, can be recognised as true solitary myeloma. The one of which this may be said with greatest certainty is their no. 18:

Case 21. — A Negro man, age 52, was admitted to hospital in December, 1924, with pain in the right leg following an injury. The roentgen examination revealed a destructive lesion of the body of the second lumbar vertebra. The diagnosis was giant cell tumor. In August, 1930, symptoms of compression developed, for which roentgen therapy was given. In December, same year, a stabilising operation was done. Microscopic diagnosis at this time was plasma cell myeloma. Later complete skeletal roentgen examinations showed no other bone involvement. The urine showed no Bence-Jones protein. In August, 1934, when the patient was last examined, there was perhaps a beginning spread of the disease to the adjacent vertebrae, but repeated examinations of the entire skeleton showed no other tumors.

The long period of observation in this case is sufficient in itself to make one accept it as true solitary myeloma. It is perhaps a weak point that the microscopy was not done until 6 years after the first roentgen examination. A trauma figures in the anamnesis of many cases of myeloma, and it is possible that also in the present one a tumor of that character may have developed in an originally traumatic lesion of the vertebral body. If this was indeed the case, the period of observation would be »only» 4 years.

The other case of CUTLER, BUSCHKE and CANTRIL's referred to above is their no. 16:

Case 22. — A woman, age 39, developed pain in the left hip 2 years prior to the first examination. Upon her admission to hospital there was a round, firm swelling over the left anterior superior spine of the ilium. A biopsy showed plasma cell myeloma. The urine contained Bence-Jones protein. Repeated roentgen examinations of the skeleton did not reveal other foci. The tumor in the left iliac bone had the roentgenographic appearance of a giant cell tumor. The patient received roentgen therapy, but died 2 years later. At necropsy myeloma of the left ilium was found. In addition there were pulmonary abscesses and chronic nephritis. Gross examination of the skeleton revealed no other bone foci.

The period of observation in this case — 2 years — is too short to permit any conclusion as to whether it was a solitary myeloma. The examination of the skeleton at necropsy was merely macroscopic, and diffuse myelomatosis can only be excluded on the basis of *microscopic* examination. Besides, as CUTLER, BUSCHKE and CANTRIL themselves remark, the kidney changes, associated with Bence-Jones proteinuria support the view that the disease had become generalised. Their other cases from the Bone Registry are very doubtful. The diagnosis rests on the roentgenographic appearance alone, and in all of them generalisation occurred after some months, at most after 3 years. In their case no. 19 there are two roentgenologically demonstrable foci from the start.

A few other cases of supposedly solitary myeloma are mentioned by MAGNUS LEVY, CLAREMONT, GESCHICKTER and COPELAND, and HELLNER; but in such a way that the description offers no basis for testing or verification. A case reported by CABOT (CUTLER, BUSCHKE and CANTRIL's no. 9) must be eliminated, because the histologic diagnosis is very uncertain. GRÜNEIS is right when, in the title of his paper, he uses the expression: an *apparently* solitary myeloma. ROWLAND's case is certainly not one of myeloma, inasmuch as his definition of that disease does not correspond with the modern one. According to him a myeloma is »an innocent tumor of bone which grows from the red marrow, which it closely simulates in structure, being chiefly composed of multinucleated giant cells embedded in spindle and round cells». And later: »It is curious that this disease rarely affects the abundant cancellous tissues of the bodies of the vertebræ».

To the above cases we are able to add the observation of two, which formerly would have been considered as solitary myelomas, because they fulfil all the criteria hitherto employed in determining if a myeloma was solitary. Sternal puncture showed them, however, to be elements of a generalised myelomatosis.

Case I. — A man, farmer, age 61, had undergone an operation, in 1918, for an affection of the kidneys, the nature of which could not now be ascertained. Apart from this he had always been in good health. In April, 1935, he had a collision with a railway train while driving his motor car. He sustained a fracture of several ribs and a trauma to the right shoulder. Roentgen examination of the shoulder region showed a doubtful fracture of the scapula, but no sign of tumor. In June, 1936, he fell while working in his garden, striking the ground with his right shoulder. In the interval between these two accidents he had commenced to experience a pain in the shoulder, and was being treated with massage. After the second accident the pain increased, and did not respond either to massage or to roentgen therapy (100 r × 3). On March 7th, 1938, he was admitted to the clinic of the Radium Centre for Jutland, as a roentgenograph now revealed changes pointing to a possible giant cell tumor. At admission the patient looked healthy and robust. Physical examination revealed nothing abnormal except in the region of the right

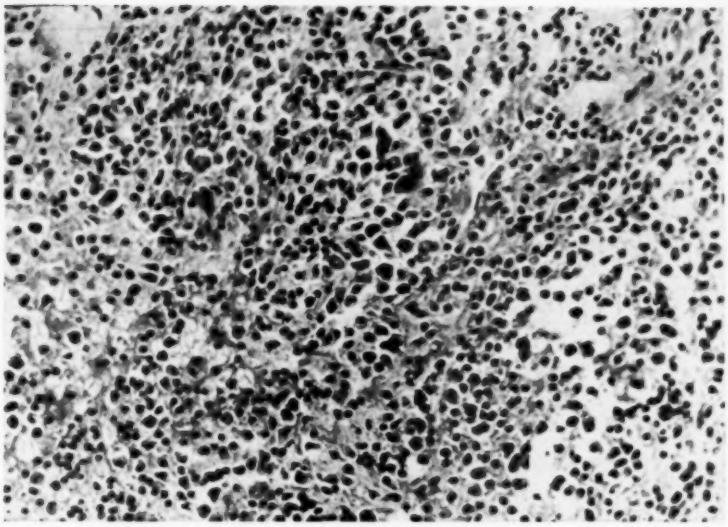

Fig. 1. — Photomicrograph of tumor removed from the scapula in Case I. Typical plasmocytoma. × 600.

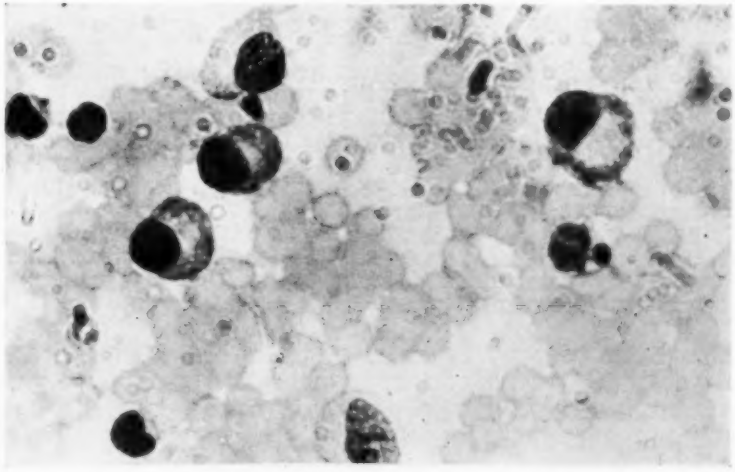

Fig. 2. — Photomicrograph of plasma cells (myeloma cells) in sternal marrow withdrawn by sternal puncture in Case I. Smear preparation stained with hematoxylin-eosin. × 1,200.

shoulder joint, where there was a diffuse swelling of the extreme lateral part of the scapula and ankylosis of the joint. Roentgen films (Fig. 3) showed a very irregular trabecular design of the entire upper and lateral half of the scapula. The glenoid cavity, coracoid process and part of the acromion were completely destroyed. The trabecular design was visible through the caput humeri, seemingly indicating that the process had spread laterally into the soft tissues at the level of the latter. The picture, with its polycystic appearance, most nearly resembled what one sees in cases of a giant cell tumor, but could not in itself exclude the possibility of a malignant bone tumor. In the upper part of the humerus there were scattered, spotty areas of rarefaction, presumably indicating calcareous atrophy. In the lungs were seen a number of calcifications in both hilus regions, but no signs of metastases. There were no signs of malignant neoformations in any of the ribs. The sixth on the right side showed a completely healed fracture. Complete skeletal roentgenography revealed no other signs of tumor, nor any calcareous atrophy.

On March 15th, a biopsy of the tumor was performed, and greyish-red gelatinous tissue encountered. Microscopy, by Dr. GREGERSEN, showed typical plasma cell myeloma (Fig. 1). On March 18th, sternal puncture was done. The bone marrow aspired was rich in cells. Differential count of 1,000 gave 422 typical plasma cells, rather large, with basophilic, in some instances vacuolised cytoplasm and round, excentrically situated nucleus rich in chromatin. Many nuclei showed the typical spoke-like structure (Fig. 2). There is thus no doubt about the myelomatosis.

The patient's urine all the time contained large quantities of albumen, both albumin and considerable amounts of Bence-Jones protein. Microscopy showed a few erythrocytes, many epithelial cells and a quantity of granulated cylinders. Albimunuria and granulated cylinders had been found already in 1936, but at that time no test had been made for Bence-Jones protein. The serum proteins were altered in the manner characteristic for myelomatosis. There was hyperproteinemia with elective hyperglobulinemia, thus: total protein 11.1 per cent., albumin 3.4 per cent., globulin 7.7 per cent. (relative globulin fraction 69 per cent.). The formol-gel reaction was repeatedly positive (1 h.). Blood precipitation varied from 52 to 88 mm./h.; hemoglobin from 84 to 75 per cent.; red blood cells from 3.84 to 3.52 millions; white cells from 2,420 to 4,950. Differential counts at various times gave fairly constant results; thus on April 9th, 1938: leucocytes, neutrophile, 70 per cent.; eosinophile, 3.3 per cent.; basophile, 0; lymphocytes, 15 per cent.; monocytes, 1.6 per cent. Once a myelocyte was found, but on no occasion plasma cells. The red blood cells showed moderate anisocytosis; none contained nuclei. Serum calcium was 9.9 mgm. per cent., serum phosphor 2.9 mgm. per cent., plasma phosphatase normal: 4.1 units (Dr. H. BUCH); blood urea 20 mgm. per cent.; serum cholesterin 110 mgm. per cent.; Wassermann negative; blood pressure 150/90.

The patient received roentgen therapy (160 kv., 4 ma., 1 mm. Al. + 1 mm. Cu., distance 40 cm.): 2,000 r from in front and 2,000 r from behind, to the right shoulder. The treatment had considerable effect in relieving the pain, but roentgenologically there is no demonstrable change in the process.

Through the courtesy of senior physician, Dr. STUERUP, Lemvig, we have obtained the roentgenographs reproduced here (Figs. 3, 4 and 5) of the patient's shoulder shortly after the first trauma. In Fig. 3 is seen a doubtful fracture of the scapula, but the others show how the tumor gradually grew larger.

It may be added that during the whole course of his disease the patient had symptoms only from his shoulder. In all other respects he is perfectly well, and takes active part in the work on his farm.

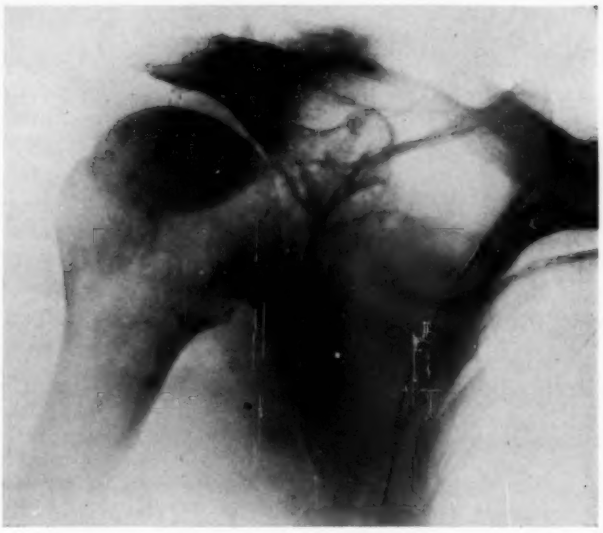

Fig. 3. — The scapula in Case I. March 17th, 1935, immediately after the first trauma had been sustained.

Fig. 4. — The scapula in Case I, June 11th, 1936.

Fig. 5. — The scapula in Case I, March 8th, 1938.

Fig. 6. — The destruction in the left pubic bone in Case II, as it appeared on March 10th, 1938, before treatment was instituted.

Recapitulation:

A man, age 61, complains of neuralgiform pain after trauma to the right shoulder. Massage treatment fails to produce improvement. A roentgen examination of the scapula shows doubtful fracture, but otherwise nothing positively abnormal. In the following three years increasing destruction develops, however, in the right scapula; but after fully three years' observation the patients' general health is nevertheless unaffected, and roentgen examination reveals no other skeletal destructions. A biopsy shows plasma cell myeloma, and sternal puncture reveals diffuse myelomatosis. It would have been of interest if this case had been followed up with examinations of the bone marrow from the time of first observation.

Case II. — Man, age 58, manager of electrical works. Seventeen years ago he had had a brownish tumor removed from the skin of his right forearm. He had been told at the time that it was malignant, and had received roentgen treatment. Twelve years later there came a slight local recurrence, which was excised. Otherwise he has always been in good health. For the last six months he has, without preceding trauma, had increasing pain in the left hip, compelling him to use a stick when walking. For three months past he has been in another hospital, treated without effect with massage and diathermy. He has lost 12 pounds in weight and has been very fatigued. Anemia was found, with hemoglobin 46 per cent. Repeated roentgen examinations of the pelvis were negative. Finally, in March, 1938, an area of rarefaction was found in the left pubic bone. This was judged to be a mestastasis from the old carcinoma, and on March 3rd, 1938, the patient was transferred to the clinic of the Radium Centre for Jutland. At admission here he was pale, fatigued and thin, suffered greatly with pain and could hardly walk. The general examination showed nothing abnormal except somewhat restricted mobility in the left hip. Roentgen examination of the pelvis showed a distinct defect in the superior ramus of the pubic bone. There was no bone regeneration or periosteal reaction. Also the bony structure corresponding to the bottom of the acetabulum was somewhat rarefied, an in the head of the femur there was a slightly spotted bone atrophy. There could hardly be any doubt but that it was a malignant tumor. Whether it was primary or secondary could not be determined from the picture. The osseous structure of the bones visible in the film was rather curious, and richer in contrast than normally (Fig. 6). Complete skeletal roentgen examination showed in all parts diffuse, speckled atrophy of the bones, but no foci anywhere.

The urine did not contain Bence-Jones protein. The blood showed severe anemia: Sahli 58 per cent., red blood cells 2.35 millions, white blood cells 1,687; differential count: leucocytes, neutrophile 66 per cent., eosinophile 4.5 per cent., basophile 0; lymphocytes 28.5 per cent.; monocytes 0; myelocytes 1.5 per cent. The precipitation reaction was very high: 154 mm./h.; the formol-gel reaction positive after 4 hours. Owing to the high precipitation and positive formol-gel reactions a sternal puncture was done on March 24th, 1938. Differential count of 1,000 cells gave 220 plasma cells; or four times the number generally considered as the upper limit. The diagnosis of myelomatosis might thus be considered as positively established. Also in this patient there were characteristic changes in the albumen of the blood; the total of protein being 9.05 per cent., albumin 3.5 per cent., globulin 5.25 per cent. (relative globulin fraction 58 per cent.). Serum calcium was 10.6 mgm. per cent.; serum phosphor 3.5 mgm. per cent., plasma phosphotase

normal: 9 units (Dr. H. Buch); blood urea 33 mgm. per cent.; blood pressure 155/1[illegible]; basal metabolism 113.3 per cent.; Wassermann negative.

The patient was given roentgen therapy, 2400 r each to a posterior and anterior field over the tumor, the factors being 160 kv., 4 ma., 1 mm. Cu. + 1 mm. Al., distance 40 cm., The treatment did much to relieve the pain, and also the patient's walk improved. Following the local roentgen therapy the patient was given a series of general roentgen treatment in the hope of checking the diffuse myelomatosis (90 r in all; given with 10 r on alternate days. Factors: 150 kv., 3 ma., 0.5 mm. Cu. + 1 mm. Al.; distance 150 cm.). Under this treatment his general condition improved. At after-examination on July 15th, 1938, the hemoglobin percentage was found to be 75, red cells 3.27 millions, white cells 3,696. A roentgen examination of the pelvis made at the same time showed that the destruction in the pubic bone on the left side has almost completely disappeared.

SUMMARY

The authors report 2 cases of apparently solitary myeloma, in which examination of the bone marrow showed the tumor to be part of a generalised myelomatosis. They further review the cases of solitary myeloma reported in the literature, and show that of 27 such only 2 can be considered as proved, while in 3 more the clinical course makes the diagnosis fairly certain. They suggest that in future sternal puncture should be performed not only in all cases of myeloma, but in all cases of bone disease where the diagnosis is uncertain; as, in this way, a material would eventually be obtained, which might contribute to the understanding of the pathogenesis and prognosis of myeloma, and give useful information for the therapy to be employed.

ZUSAMMENFASSUNG

Die Verfasser teilen 2 Fälle von anscheinend solitärem Myelom mit, bei welchen eine Knochenmarkuntersuchung zeigte, dass der Tumor Teil einer generalisierten Myelomatose war. Sie referieren die in der Literatur mitgeteilten Fälle von solitärem Myelom und zeigen, dass von 27 dieser Fällen nur 2 als bewiesen betrachtet werden können, während in 3 weiteren der klinische Verlauf die Diagnose ziemlich gewiss erscheinen lässt. Sie schlagen vor, dass in Zukunft nicht nur in allen Fällen von Myelom Sternumpunktion ausgeführt werden soll, sondern in allen Fällen von Knochenerkrankung, wo die Diagnose nicht sicher ist, da auf diese Weise vielleicht ein Material erhalten werden könnte, das zum Verständnis der Pathogenese und Prognose des Myeloms beitragen und nützliche Informationen für die anzuwendende Therapie geben mag.

RÉSUMÉ

Les auteurs rapportent 2 cas de myélomes apparemment solitaires, dans lesquels [illegible]as l'examen de la moelle des os montra que la tumeur faisait partie d'une myélomat[illegible]se généralisée. Ils passent également en revue les cas de myélome solitaire rapportés d[illegible]ns

la littérature, et montrent que dans 27 tels cas, seuls 2 peuvent être considérés comme prouvés, tandis que dans 3 autres cas l'évolution clinique rend le diagnostic assez certain. Ils suggèrent qu'à l'avenir, une ponction sternale soit opérée non seulement dans tous les cas de myélome, mais aussi dans tous les cas d'affection des os où le diagnostic est incertain; on obtiendrait de la sorte une matière qui pourrait contribuer à la compréhension de la pathogénèse et du prognostic du myélome, ainsi que fournir d'utiles indications au sujet de la thérapie à appliquer.

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